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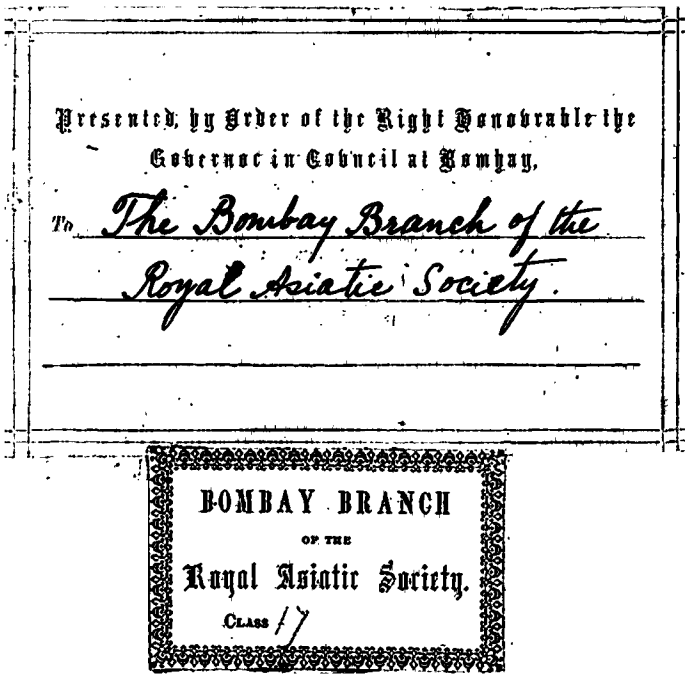

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For a reference to the principal points of interest discussed in the magnetic papers which form the Appendices of this volume, see page [iii].

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS

MADE AT THE

GOVERNMENT OBSERVATORY,

BOMBAY,

1879—1882.

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MAGNETICAL AND METEOROLOGICAL OBSERVATIONS

MADE AT THE

GOVERNMENT OBSERVATORY, BOMBAY,

IN THE YEARS 1879 TO 1882,

UNDER THE SUPERINTENDENCE OF

CHARLES CHAMBERS, Esq., F.R.S.,

AND

F. CHAMBERS, Esq.

133497

TOGETHER WITH APPENDICES CONTAINING ACCOUNTS OF MAGNETIC RESEARCHES, EMBRACING OBSERVATIONS EXTENDING OVER A PERIOD OF THIRTY-SEVEN YEARS.

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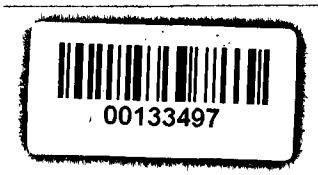

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1883.

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ERRATA IN MAGNETICAL AND METEOROGICAL OBSERVATIONS, 1879 TO 1882.

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INTRODUCTION

TO THE

METEOROLOGICAL AND MAGNETICAL OBSERVATIONS,

1879 TO 1882.

OF the series of volumes entitled "Bombay Magnetical and Meteorological Observations" the present one is the twenty-third, extending the record, which before embraced the years 1845 to 1878, up to 1882.

2. The latitude and longitude of the Colába Observatory are 18° 53′ 45″ north and 72° 48′ 56″ east respectively.

3. *Local situation.*—The Observatory is situated at the extremity of a narrow strip of land extending two miles to the south-westward of the Fort of Bombay and separating the harbour and Back Bay. Trap rock, which is very abundant in the ground near and on the surrounding sea-beach, crops up at many places through the red sandy soil which covers the greater part of the Observatory enclosure. During the rainy months of the year, the soil is overgrown with grass, which, however, is quickly burned up when the dry season comes round. The nearest elevated ground is Malabar Hill, which lies on the opposite side of Back Bay, at a distance of four miles, but that which subtends the largest vertical angle, as seen from the Magnetical and Meteorological Observatory, is the southern hill of the Island of Karanja, at a distance of about eight miles, across the harbour. The altitude of the highest point of the latter is less than 1° 7′. An idea of the aspect and nature of the surrounding country, and of the exposure of the thermometer shed and anemograph, may be obtained by inspection of the photographs—forming a series of panoramic views all round the compass, together with some near views of the buildings and instruments—which accompanied the "Meteorology of the Bombay Presidency" published in 1878. In the same work will be found a plan of the grounds and buildings of the Observatory, and an index showing the names and uses of the several buildings, and the location of trees of large and small growth.

The buildings concerned with the production of the observations recorded in this volume are, (1) the Astronomical Observatory and the Anemometer Tower, with a western wing, the greater part of which serves as a computing room, whilst the remainder is partitioned off for a photographic operating room; (2) the Magnetical Observatory with the adjoining Electrometer Tower; (3) the underground Magnetograph room; and (4) the Thermograph Shed, enclosing the thermograph room; to which may be added the old thermometer shed.

4. *Superintendence of the Observatory.*—The observations of the years 1879 to 1882 have been taken under the superintendence of the officers whose names follow, and during the several periods put opposite to their respective names:—

Charles Chambers, Esq., F.R.S., from 1st January 1879 to 16th February 1882, and from 17th May 1882 to 31st December 1882.

F. Chambers, Esq., from 17th February 1882 to 16th May 1882.

5. *Observatory Establishment.*—In the Magnetical Department of the Observatory there are one First Assistant, one Second Assistant, three Observers and one Computer; and in the Astronomical Department one First Assistant

and one Second Assistant. These several offices were filled, during the four years 1879 to 1880 in the manner exhibited in the following statement :—

Name of Officer.	Department.	Name of Office.	Period.		Initials.
			From	To	
Vinayek Narayen Nene ..	Magnetical...	First Assistant ...	1st Jan. 1879 ...	31st Dec. 1882 ...	V. N.
Crishnaji Ganesh Thakur .	Do. ...	Second Assistant.	Do. ...	Do. ...	C.
Vithal Govind Ghaneker .	Do. ...	Observer ...	Do. ...	Do. ...	V. G. G.
Tukaram Ganesh Vevara.	Do. ...	Do. ...	Do. ..	8th June 1879...	T.
Ramchandra Govind Joshi.	Do. ...	Do. ...	20th June 1879...	22nd June 1880 .	R. G.
Krishnaji Govind Oka ...	Do. ...	Do. ...	23rd June 1880...	31st Dec. 1882 ...	K.
Vishnu Damodhar Benderker.	Do. ...	Do. ...	1st Jan. 1879 ...	4th Aug. 1882 ...	V.
Ganesh Sadashiv Joshi ...	Do. ...	Do. ...	21st Dec. 1882 ...	31st Dec. 1882 ...	G. S. J.
Govind Narayen Vedak...	Do. ...	Computer ...	1st Jan. 1879 ...	Do. ...	G.
Hari Chintaman Karkanis.	Astronomical	First Assistant ...	Do. ...	Do. ...	H.C.
Purshuram Laxuman Datar	Do. ...	Second Assistant.	Do. ...	Do. ...	P.

The initials marked in the last column are those which the respective observers attach to the several observations made by them. The initials used by Mr. Charles Chambers are C. C. and those used by Mr. F. Chambers are F. C.

6. *System of observation and reduction and distribution of duties.*—The Astronomical Observatory is furnished with a transit instrument and a sidereal clock, which are used for the determination of local time, primarily for communication to the shipping in the Bombay harbour, and secondarily for communication, by comparison of chronometers three times a week, to the Magnetical and Meteorological Observatory.

Observations are taken and entered in the registration forms every day, without exception, at the hours 6, 10, 14, 16, and 22,—the day commencing from midnight at Bombay (Colába) and being reckoned from 0^h to 24^h. One observer (called the morning observer) takes the 6^h observation, a second one (the day observer) those of 10^h, 14^h and 16^h, a third one (the night observer) that of 22^h, and a fourth is relieved from observing duty for one week; the next week the four observers change round in circular order, and so on week by week. On Sundays and general holidays special arrangements are made to set free all but three members of the staff—one being kept on observing duty, one in charge of photographic instruments, and one in charge of the Astronomical Observatory. All the observers reside on the premises and they are required to keep a general out-look on the weather during the intervals between their respective hours of observing duty and the next earlier observation hours. Each observer reduces his own observation immediately after the entry of the observation in the register, and the reductions are checked by the observer who next comes on duty: amongst the duties of the day observer are included the calculation of daily averages, and the writing out of the monthly abstracts. These latter consist of tables having the days of the month marked in numerical order in the first column and the hours of the day in order at the head of the columns, and there is one for each magnetical or meteorological element observed. Attendance in the computing room is exacted of the observers, when not actually engaged upon observing duty, as well as of the First Assistant, Magnetical Department, Second Assistant, Astronomical Department, and Computor, for six hours daily, exclusive of a break for rest in the middle of

the day. Upon the First Assistant devolve the immediate oversight of general observing, computing and photographic operations. The observations of absolute declination, horizontal intensity, and dip, which are repeated once, twice and twice respectively every week, are distributed amongst the more experienced observers in such a manner that no two consecutive weeks' observations should, as a rule, fall to the same observer. The time of one Assistant is almost entirely absorbed by the photographic operations, the instruments requiring vigilant attention, and the chemical processes much skill and care.

The anemograph is in charge of the Second Assistant, Astronomical Department, who changes the recording paper daily, and tabulates the hourly readings of direction and movement of the wind. The tabulations are checked by the Photographer between whom and the Second Assistant, Astronomical Department, are divided also the resolution of the tabulations into components and the writing out and checking of wind abstracts, the one performing a set of operations and the other checking them, and so on alternately. The correspondence of the direction record to the actual direction of the vane is frequently checked by turning the instrument to point to the Kennery Lighthouse, the azimuth of which is accurately known. In order to preserve the direction gear in smooth working condition, the fixed toothed wheel is cleaned and oiled—without stopping the instrument—once a week; and every day the direction vane is turned right round the compass once each way, with the object of lubricating both sides of the teeth of the wheel.

All computing operations are systematically checked by a repetition of the operation by another computer.

17. The eye-observations that are taken five times a day are subsidiary to continuous registrations obtained by means of automatic recording instruments. Of these there are five sets of apparatus,

I. The magnetographs,
II. The barograph,
III. The thermograph,
IV. The pluviograph, and
V. The anemograph,

of which IV is an appendage of III, designed to work with the same light and to trace its curve on the same sheet of sensitive paper. The first four register photographically and the last mechanically.

8. *Instruments and phenomena observed five times a day.*—These are as follows:—

Extent and description of clouds, state of the weather, occasional phenomena, and direction of the wind.		From 5 minutes before to 2 minutes after the exact hour.
Thermograph standard thermometer, dry bulb		At 2 minutes after the exact hour.
Do. do. wet bulb		At 2 minutes after the exact hour.
Newman's rain gauge (in wet season)		„ 3 „ „
Osler's do. (do.)		„ 4 „ „
Air thermometer	In old thermometer shed.	From 5 to 7 „
Wet bulb thermometer	In old thermometer shed.	From 5 to 7 „
Thermometer in ground 1 inch deep.	In old thermometer shed.	From 5 to 7 „
Do. do. 9 inches deep	In old thermometer shed.	From 5 to 7 „
Newman's standard barometer No. 58 and attached thermometer.		„ 7 to 9 „
Do. do. No. 48 ditto.		„ 7 to 9 „
Old vertical force magnetometer and its thermometer		At 10 „ „
Grubb's declination magnetometer		„ 12 „ „

Grubb's horizontal force magnetometer and its thermometer	At 14 minutes after the exact hour.		
Vertical force magnetograph and its thermometer*	„ 17	„	„
Declination magnetograph*	„ 18	„	„
Horizontal force magnetograph and its thermometer*	„ 19	„	„
Thermometer attached to barograph ...	„ 20	„	„

Maximum and minimum thermometers in the magnetograph room are read and re-set at 10 hours only, and the 20 inches, 60 inches and 132 inches deep ground thermometers are read at 14 hours only.

The rain gauges—Newman's and Osler's—are read daily at midnight in the wet season, and the discharges of the syphon of the self-registering rain gauge once a day or oftener as required.

9. *Other routine operations.*—(1) The anemograph is supplied with fresh recording papers daily.

(2) Fresh sensitive papers are put upon the recording cylinders of the three magnetographs, of the barograph, and of the thermograph and pluviograph every two days. The papers taken off are developed, fixed and washed, and new ones are prepared by the photographer on alternate days.

(3) The tabulation of anemograms is effected as soon as the papers are available, generally, that is, on the day following that to which the record refers. Barograms and thermograms also are regularly tabulated as soon as the registers are available.

(4) Observations of vibration and deflection are made with the unifilar magnetometer for the determination of the absolute horizontal force weekly, and with the same instrument observations of absolute declination are also made weekly.

Observations of magnetic dip are made twice a week.

The time of vibration of the magnets of the three old differential magnetometers are observed once a month or oftener.

(5) Transit observations of stars for the determination of time are made generally on Mondays, Wednesdays and Fridays in the dry months: during the monsoon no opportunity is lost of observing the sun or stars when visible. The adjustment of the transit instrument is frequently tested by reference to the fixed collimator mark; the collimation, level, and azimuthal errors are determined from time to time, and whenever the collimator shows a displacement of the telescope, or any considerable discordances appear in the clock errors derived from observations of stars of different north polar distances.

Remarks on the Condition and Adjustments of the Instruments and on the Processes of Reduction.

10. The object of the following description is to make known such special circumstances in connection with the condition, situation and adjustment of the instruments, with the habits of the observers, and with the routine of the processes of reduction, as are necessary to enable the reader to form an independent judgment of the degree of precision attained, and of the weight to be attached to any conclusions that may be drawn from the observations.

* Also the vacuum gauge when the enclosure is partially exhausted.

I.—METEOROLOGICAL INSTRUMENTS, 1879 TO 1882.

BAROMETER.

11. *Description.*—The observations which have furnished the data for the construction of the tables of barometric pressure for the years 1879 to 1882 are taken with a standard barometer by Newman, marked No. 58, the same which has been used uninterruptedly since the establishment of the Observatory. The internal diameter of the barometer tube, marked by the maker on the frame of the instrument, is 0·530 inch. The scale, which is of brass, is moveable, and terminates below in an ivory point which is designed to be set, at each observation, so as just to touch the surface of the mercury in the cistern, and the setting is known to be accurate when the point appears just to meet its image reflected from the mercury. The upper part of the scale, which is divided to twentieths of an inch, has a vernier with slow motion screw, reading to thousandths of an inch, and to it are attached two small brass plates with horizontal lower edges before and behind the tube: the setting of the instrument consists in raising and lowering the vernier until the horizontal plane containing these two edges is tangent to the surface of the mercury in the tube of the barometer, and this is the case when it is just so low, and no lower, that when the eye is raised or lowered no light is seen to pass between the central part of the mercurial surface and the two edges. A thermometer with a cylindrical bulb dipping into the mercury in the cistern is attached to the barometer, and is read at every observation.*

The standard barometer is attached by means of brackets to a flat board which hangs against the wall on the eastern side of the Magnetical Observatory, near the north-east corner of the room, and its cistern has an elevation of 37 feet above the mean sea level at Colába. It was lifted down in May 1866 and the mercury carefully caused to run up to the top of the tube, where it gave the sharp metallic stroke that is indicative of a good vacuum. It is stated in the "Report of the Committee of Physics of the Royal Society, 1840," page 56, where a description is given of a class of barometer of which this is an individual, that the scale is laid off from the zero point from an authentic standard. The tube of the barometer is kept in proper adjustment to verticality.

12. *Error in setting the Zero point of the scale, and change of method of observation.*—In the long period that has elapsed since the instrument was mounted (in 1841) there has been a gradual accumulation of scum on the surface of the mercury in the cistern, and the glass cistern has become more and more opaque until at the present time the reflected image of the ivory Zero point of the scale is very obscurely seen, so that the operation of setting the Zero of the scale is uncertain to a very sensible degree. For this reason, the method of observation which had always previously been in accordance with the above description, was changed on the 22nd May 1866, so as to avoid the necessity of setting the scale at every observation. The scale was set once for all on that day and the setting screw then removed; and suitable corrections were thereafter applied for the rise and fall of the mercury in the cistern. These were taken from a table calculated by the formula†

$$\text{Capacity correction} = \cdot 04321\ (h_0 - 29\cdot 943)$$

where h_0 represents the uncorrected reading of the barometer. As the departure of the barometer reading from its mean value very rarely reaches 0·4 inch, which would require a correction of only ·017 inch, it is very improbable that an error of so much as ·001 inch ever occurs from inaccuracy in the adopted value of the relative capacities of the tube and cistern: since the change was

* See preceding volume, Introduction, paragraphs 70 and 72.

† The date for the construction of this formula will be found in the "Bombay Magnetical and Meteorological Observations, 1865-70, Introduction, pp. x. xi."

made, the comparability of the observations for showing variations is therefore throughout much better secured.

13. *Corrections applied to the observed readings.*—It was stated in the instructions given in the Report of the Committee of Physics (page 56) that the correction for capillary action in barometers of this description is rendered inappreciable by the large diameter of the tube. Consequently no correction for capillarity has ever been applied, and the only corrections besides those for capacity, which have been applied, and that invariably from the first, are for reducing the observations to what they would have been if the temperature of the mercury had always been 32° Fahr. and that of the brass scale 62° Fahr., and these corrections were taken from Table II. of the Committee's Report.

14. *Comparison with the Kew Standard Barometer.*—Indirect comparisons of Newman's barometer No. 58 with the Kew standard have been made through the mediation of two mountain barometers by Negretti and Zambra, numbered 705 and 711 : in Bombay these were both found to read ·011 inch higher than Newman No. 58, whilst in England they had been found to be ·007 and ·006 inch respectively above the Kew standard : hence Newman's No. 58 reads on the average ·004 inch below the Kew standard. It happens that this is exactly the average amount by which the readings of Newman's barometer have been over-reduced for temperature (*see* preceding volume, Introduction, paragraph 72).

Ground Thermometers.

15. Thermometers with their bulbs at the respective depths below the surface of the ground of 1, 9, 20, 60 and 132 inches are regularly observed, the two former five times a day and the three latter once a day at 14 hours. They are all by Newman, of London, and are divided on brass scales, and the value of one division, approximate range of part of scale exposed above ground and lengths of that part and of one average degree are shown for each thermometer below :—

Depth of Bulb.	Divided to	Approximate Range of exposed part of Scale.	Length of that Range.	Average length of 1°.
Inch.			Inches.	Inch.
1	1°	30° to 145°	8·19	·071
9	0°·2	70° to 115°	5·20	·116
20 *	1°	35° to 160°	6·73	·054
60	1°	35° to 160°	6·81	·054
132*	1°	50° to 140°	6·44	·072

The 1-inch and 9-inch thermometers are on flat brass scale frames, which lie against wooden posts in the ground, and they have their bulbs in contact with the loose red earth which fills the holes in which they are placed; the 20-inch, 60-inch and 132-inch thermometers have their lower parts enclosed in brass tubes with ends curving off to a point, and the upper parts are in wooden box frames, to which the brass scales are fixed. The reason why only one observation is made daily of the three deeper thermometers is, that it had been found, by hourly observations in 1849, 1850 and 1851, that no appreciable diurnal variation of temperature reached the depth of 20 inches.

The errors of graduation of the ground thermometers are unknown.

* The regular observations of the 132-inch thermometer commenced on the 1st January 1879.

The Robinson-Beckley Anemograph.

16. *Description.*—From the beginning of the month of June 1867 was brought into use an anemograph of the kind designed by Dr. Robinson, with improvements by Mr. Robert Beckley, and it remains in action to this day. It is made by Mr. R. W. Munro, and was supplied through the Kew Committee of the British Association, after being tested at the Kew Observatory. In this instrument the arrangements for the registration both of movement and direction of the wind are mounted on one shaft, and the registrations are made on a single sheet of paper, which is changed daily. The essential part of the apparatus for measuring the movement is a vertical spindle, to which cross arms are attached at the top, carrying four hemispherical cups of copper. The cups are attached to their several arms, so that, looking from the central axis, their convex sides are seen turned to the right hand, and the wind, acting with greater effect upon the concave than on the convex sides of the cups, causes the system to rotate in a right-handed direction. It is the number of these rotations, 140 of which are reckoned to a mile of movement of the wind, that tells us how fast the wind has been blowing; and the number is reduced by means of wheel-work 7,000 times before reaching a small cylinder, carrying a brass spiral pencil that traces the movement on the registering paper; this latter is metallic paper of the kind used for pocket-books, and is wrapped round a brass cylinder, which is kept rotating by clock work, and as the paper passes under the spiral pencil, which presses slightly upon it, the black movement trace is received upon it. The wind vane, which consists of a pair of wind-mill vanes with connecting spindle having an endless screw in the middle, and gearing into a *fixed* horizontal toothed wheel, is attached to a tube that surrounds the lower part of the vertical movement spindle; to the bottom of the tube is fixed a toothed wheel, which, in communication with other such wheels, conveys the motion of the vane *unchanged* to a small cylinder with spiral pencil, which traces the changes of direction on the register; and it is so arranged that the movement and direction are traced on parallel strips or bands of the same sheet of paper. The heavy parts of the instrument—the direction vane and appendages, and two long brass tubes which connect the instrument proper with the recording apparatus—are supported on friction balls which run in grooves partially filled with oil, thus reducing the friction to a minimum. The instrument is erected on the old Time-Ball Tower, at a height of 53 feet above the ground, and 95 feet above the mean sea level, over a platform 12 feet in diameter, which is designed to give ready access to the instrument, and to protect it from irregular currents of wind, glancing from the convex surface of the dome; and it is supported outside by a fixed cast-iron standard, to which is attached, at the top, the toothed wheel, into which the endless screw of the spindle connecting the windmill vane gears. The centres of each pair of opposite hemispherical cups are four feet apart, and three and a half feet above the platform, and the diameter of the cups is nine inches. The diameter of the vanes is 15 inches, and the breadth of the fans four inches. The register form is printed in red, with lines dividing its length into hour spaces; and its breadth, on the movement side, into five spaces, each representing 10 miles of movement of the wind, and numbered from 0 to 50 miles; and on the direction side into spaces corresponding to 11¼ degrees on each side of the 16 principal directions N., N.N.E., N.E., &c..... N.N.W., which spaces are numbered consecutively 1, 2, 3, &c..... 16.*

17. *Tabulation of Anemograms.*—Numerical tabulations have been made of the movement and direction of the wind during the interval between every two successive hours in the following manner:—the number of miles indicated at the point where the velocity trace cuts a horizontal hour-line being read for two

* A more detailed account of the Colába anemograph will be found in the "Bombay Magnetical and Meteorological Observations, 1865 to 1870," Appendix I. page 199.

successive hours, the excess of the latter over the former reading (adding 50 if the trace has passed over from left to right of the form) gives the movement for the interval; and the number of the space in which the direction trace lies during the interval is entered as representing the direction. The estimations of movements are made only to the nearest full mile. Should the direction trace not lie all in one space during the whole interval of an hour, then if the change of direction exceed 90° or eight points, the whole observation for that hourly interval is rejected; but if it lie within that limit the direction is estimated—by an inspection of the movement and direction traces together—from whence the aggregate flow of air was the greatest, and this direction is adopted for the full hour. In the first year, out of 8568 hours, during which the instrument was in action, 16 only had to be rejected because the direction of the wind varied more than eight points within the hour.

18. *Method of reduction.*—Hitherto we have had to speak of phenomena liable only to simple increase and decrease of value, and not subject to any change of quality. Such phenomena being properly and completely evaluated by simple numbers, we may apply to the numbers any arithmetical operations, such as averaging, and infer from the results of those operations corresponding properties of the phenomena. But we have now come to a phenomenon which requires two numbers to express it, one representing its amount and the other a varying quality; the first referring to the velocity, and the last to the direction of the wind. Here we may no longer apply arithmetical processes directly and indiscriminately to the observed numbers; but, the subject being one of motion, we must treat them according to the principles of the science of motion. These principles tell us that the motions may be equally well expressed by means of two varying numbers referring to two invariable qualities, as by a varying number referring to a varying quality; and they show us how to obtain either form of expression from the other. The invariable qualities chosen in the present case are the directions north and east, the actual wind blowing in each hour being resolved into north and east components, which may be regarded separately as the velocity of the wind in the invariable direction north or south, and the velocity of the wind in the invariable direction east or west. The resolutions are effected by means of the formulæ:—

$$\text{North component of velocity of wind} = m \cos (n \times 22\tfrac{1}{2}^\circ),$$
$$\text{East component of velocity of wind} = m \sin (n \times 22\tfrac{1}{2}^\circ),$$

where m is the movement observed, and n the number of the direction space under which the wind of the hourly interval is classed. When the sign of either of these calculated quantities is negative, it implies that the wind blows from the opposite direction, *i.e.* from south or west. The calculations are readily made by means of tables to the nearest tenth of a mile of velocity per hour. Having now substituted the two equivalent winds for the real one, we may with propriety proceed to combine together numbers of observations by algebraical addition and averaging, treating the north and east components of the wind each by themselves. The averages thus found from the observations of any given period will represent the velocity with which the wind must blow from the northward (from the southward if the sign of the average be negative) continuously for the whole period, in order that the total movement of the wind from that direction may be the same as the total movement from the same direction produced by the winds which actually blow, and similarly the velocity with which it must blow continuously from the eastward (westward if the sign of the average be negative).

No corrections have been applied to the anemograph tabulations on account of friction.

Rain Gauges.

19. *Newman's Rain Gauge.*—This instrument is made of copper, and exposes for the collection of rain-drops a circular surface of an average diameter of 12·035 inches, forming the top of a funnel, that carries the rain into a cylindrical vessel below, having a diameter of 5·732 inches: a float of slightly less diameter, so as to rise and fall freely, rests upon the water in this vessel, and having a wholly convex external surface, it allows the rain as it falls to flow off and raise the level of the water and with it the float; to the middle of the float is fixed a wooden rod, graduated with divisions, each of which represents ·05 inch of rain; and the readings of this scale, which are easily estimated to fifths of a division, are made where it is cut by the upper edge of a light brass rod placed horizontally across the mouth of the funnel, but half an inch below the edge of the exposed circular surface; the scale passes through a hole in the middle of the horizontal rod, and is thus kept always in a vertical position. The range of the scale is from 0 to 4·00 inches, and the readings of the scale have been entered in the meteorological register and the differences been taken for every interval between successive observations: the rain has accumulated in the vessel generally till the reading was somewhere above 2·00 inches, when the water was let out, by means of a brass cock at the bottom, till the reading came down to 0·00 inch. This latter reading was also maintained during intervals of dry weather—when, from evaporation, the scale would otherwise have fallen lower—by pouring small quantities of water into the gauge: the reason of this is obvious, as, if some water were not always retained, the float would sometimes rest on the bottom of the vessel and so cease to perform its function of rising equally for equal increments of rain. The scale on the wooden rod was graduated so as to agree approximately with the data—the diameters of the gauge and measuring vessel—given above. The error of the scale according to which the rod was graduated was less than a thousandth of the whole.

Newman's gauge stands on a large rectangular block of stone, in a position intermediate between the Entrance Gate, the Magnetical Observatory, and the Thermograph Shed, where the altitude of the highest neighbouring object, as seen from the gauge, is about 30°. It is supported by three feet, which are embedded with lead in holes cut in the stone slab, and its circular mouth is at a height of 4½ feet above the ground and about 35 feet above the mean sea level.

20. *Osler's Rain Gauge.*—The funnel of this instrument is rectangular in shape and exposes a surface for the collection of rain of 197·87 square inches: it is supported on a frame projecting from and raised above the highest point of the roof of the Electrometer Tower: the rain is carried, by a copper pipe, to the basement of the tower, and is then discharged into a spare rain gauge of the same construction, but with a different scale, as the one by Newman described above. The reading of the scale, which was graduated to indicate true inches of rainfall, was entered every observation hour in the register, and the difference from the next preceding entry was taken by the observer at once. The height of this gauge is 46 feet above the ground and 78 feet above the mean sea level. On discharging accumulations of water from it, the reading is always brought down exactly to 0·00 inch.

Barograph and Thermograph.

21. Like the anemograph, the Colâba barograph and thermograph were supplied through the Kew Committee of the British Association, after being tested at the Kew Observatory; and they are of like construction with those adopted by the Meteorological Committee of the Royal Society for the seven observatories established by them sixteen years ago in the United Kingdom, and

still maintained by the Meteorological Council. An account of these instruments in general, with notes on the peculiarities of the Colába set and on special points in the Colába arrangement of them and utilization of their registrations, will be found in the preceding volume of this series, Introduction, pages xvi to xlvi.

22. The height of the bulbs of the thermometers above the ground is 10 feet. The cage is placed on one of the most exposed parts of the Observatory grounds and away from any building: it is, however, screened, as well as the thermograph room in which the recording apparatus is placed, by a roomy shed with a planked roof that is everywhere 2 feet above the roofs of the cage and room: the sides of the shed are of the louvre construction on an enlarged scale, with double sheets of zinc enclosing a thick layer of felt substituted for the wooden laths, and with a vertical distance from lath to lath of one foot: the lowermost two feet of the sides are guarded simply by horizontal iron rods: the roof of the shed is covered with thick felt and then with strong canvas, and the whole of the exterior—sides and roofs—is painted white.

Pressure of Vapour.

23. *Pressure of Vapour and additional capacity of the Air.*—Having obtained from the tabulations of the barograms and thermograms hourly values of barometric pressure, temperature of the air, and temperature of evaporation, the pressure of vapour was calculated for each hour with the aid of a table by the formula

$$f'' = f' - \cdot 01147\ (t - t') \times \frac{P - f'}{30}$$

in whch t and t' denote the temperatures of the air and wet bulb thermometer respectively, f'' and f' the pressure of vapour at the temperature of the due-point and at temperature t', and P the barometric pressure. The values of the pressure of vapour at different temperatures were taken from the following table, the numbers in which have been extracted from Boileau's Collection of Tables.

Table 1.—*Regnault's values of the Pressure of Vapour at different Temperatures.*

Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.	Temperature.	Pressure of vapour.
°	Inch.	°	Inch.	°	Inch.	°	Inch.	°	Inch.	°	Inch.	°	Inch.	°	Inch.
35	·204	43	·278	51	·374	59	·500	67	·662	75	·868	83	1·128	91	1·455
36	·212	44	·288	52	·388	60	·518	68	·685	76	·897	84	1·165	92	1·501
37	·220	45	·299	53	·403	61	·537	69	·709	77	·927	85	1·203	93	1·548
38	·229	46	·311	54	·418	62	·556	70	·733	78	·958	86	1·242	94	1·597
39	·238	47	·323	55	·433	63	·576	71	·758	79	·990	87	1·282	95	1·647
40	·248	48	·335	56	·449	64	·596	72	·784	80	1·023	88	1·324	96	1·698
41	·257	49	·348	57	·466	65	·617	73	·811	81	1·057	89	1·366	97	1·751
42	·267	50	·361	58	·482	66	·639	74	·839	82	1·092	90	1·410	98	1·805

To the find additional capacity of the air the pressure of vapour was deducted from the number in the above table standing opposite to the temperature of the air.

Self-registering Rain Gauge.

24. A description of this instrument also will be found in the Introduction to the "Bombay Magnetical and Meteorogical Observations," 1871 to 1878, page xlvi. In 1879 to 1882 the syphon discharges were received in a glass bottle and measured by means of graduated glass measures.

25. Before the monsoon of 1879 the old receiving vessel, which—under the pressure of its wooden lid—had spontaneously cracked, was substituted by a new one, the top of which was contracted in a small aperture just large enough to admit the bent part of the syphon: the syphon was also of larger bore, so as to discharge the vessel in 8 or 9 instead of 16 seconds: an unforeseen effect of this enlargement of the bore was that the discharging action became of less certain occurrence, the water at times trickling over the bend of the tube in considerable quantities before the proper discharge commenced. Suspecting that the fault lay in the form of the bend, this was modified in new syphons inserted in May 1880 and May 1882, but with rather worse than better results, and it is now proposed to revert once more to the syphon of narrow bore.

26. In May 1881 the mirror and lens were re-adjusted so as to make the converting factor very nearly *unity*.

26*a*. On several occasions the free flow of rain from the funnel was obstructed by crow's dung, which had been deposited upon and choked the sieve at the bottom of the funnel: to prevent birds from alighting upon the funnel a conical arrangement of pointed iron spikes surrounding the funnel was attached in 1882 and was found to be effective.

27. *Constants for converting syphon discharges into inches of rainfall.*—As the surface exposed by the rain gauge funnel is 50·286 square inches, an inch of rain contains 823·955 cubic centimeters. With the aid of a cubic centimeter measure,* successive quantities of a tenth, two-tenths, three-tenths, &c., of 823·955 cubic centimeters were poured into a suitable cylindrical glass vessel, upon which marks were made at corresponding heights, and then division lines were etched over the marks, forming a scale which read—from 0 to ·55—in true inches of rainfall at once. The intervals between the divisions of the scale were further sub-divided into tenths, so that readings could be made to the nearest thousandth of an inch of rain. On testing this measure, when completed, by pouring successively one hundredth, two hundredths, three hundredths..... fifty-five hundredths of 823·955 cubic centimeters of water into it, it was found to read everywhere within a thousandth of an inch of the truth. This measure was used exclusively from July 6, 1877 to 30th July 1879, when it was accidentally broken. Instead, however, of making another like it, a glass bottle was found whose contents were very nearly half an inch of rain, a file-mark on the narrow neck of it marking the level up to which the exact quantity of 412 cubic centimeters of water rises in it. The bottle is filled up to the mark as often as the number of discharges that have taken place, and the final excess or defect is measured by a graduated glass tube which is easily read off to thousandths of an inch of rain. The use of the bottle began on 31st July 1879 and is still continued.

28. *Measurement and distribution of syphon discharges.*—The discharges are measured daily, or oftener during heavy rainfall, and are of course always of an integral number. For each measurement the average value of a discharge is attributed to each of the intervals of time shown on the rain curve, between pairs of successive discharges; and it remains then only to distribute this quantity, for each filling of the receiving vessel, by means of tabulations of the ordinates of the rain curve. When, as is often the case, the rate of fall of the rain at the time of a discharge exceeds 2 inches per hour, it is necessary to allow for the rain that enters the receiving vessel during the known time (9 or 8 seconds) of discharge, the allowance depending on the rate of rainfall, which is easily estimated for this purpose by noting, with the aid of an appropriate paper scale, the inclination of the rain curve immediately after the time of discharge. The aggregate of such allowance is deducted from a day's (or

* Lent by Mr. F. Chambers, whose verification data show it to be accurate to a thousandth of the 100 cubic centimeters which it is designed to measure.

other) measurement before dividing the quantity equally amongst the several intervals.

29. *Determination of scale of rainfall ordinates.*—The factor for converting ordinates of the rainfall curve into inches of rainfall was found by experiments in which a determined weight or volume of distilled water was poured into the receiving vessel, and the change of length of the ordinate produced thereby was carefully measured. In experiments made on the 16th May 1879 the quantity of water poured into the vessel was 405 cubic centimeters, equivalent to ·4915 inch of rain, and the change of length of the ordinate ·483 of a true inch; whence the factor is found to be 1·018.

In other experiments on the dates named below the several quantities were :—

Date of Experiment.	Water poured in. Inches of rainfall.	Change of Ordinate. In true inches.	Converting factor.	Factor adopted for Monsoon of
1880, May 19	0·360	0·354	1·017	1880
1881, June 17	0·479	0·480	0·998	1881
1883, April 13	0·479	0·478	1·002	1882

30. The tabulations are made with the true-inch scale of the thermograph tabulating instrument, using the white line as datum; and the reading of this datum that shall correspond to the reading ·000 of the rain curve when the receiving vessel has just been discharged is re-determined whenever the adjustment of the recording apparatus is disturbed. For this purpose an average is taken of a number of measurements for all of which the rain is falling very slowly at the time of the syphon's coming into action and for a short time longer. It is necessary to select such occasions, because at times of heavy rainfall the curve has risen sensibly before the light has had time to make a distinct impression on the sensitive paper. The mode of tabulating is (1) to set the scale on the constant reading corresponding to the white line, (2) to move the sliding piece until the index is set upon the white line, and (3) to move the sliding bar till the index is set upon the curve, and then read the scale By setting the paper carefully, so that a considerable length of the white line is practically parallel to the lateral motion of the frame, the repetition of the first two operations of tabulation is avoided until many hourly ordinates have been read; and then a new setting of the paper is made for another stretch of the white line.

Description of the Tables of Meteorological Results and of the Processes of Reduction, 1879 to 1882.

31. *Barometric pressure.*—In Tables I, IX, XVII and XXV is shown, for every day in the four years, the mean of 24 hourly tabulations of the barograph, corrected* to agree with Newman's barometer No. 58;—also the mean pressure for each month and each year, and the excess of each monthly mean above the annual mean for the same year;—the principal features of the annual variation are also indicated at the foot of each table. The maximum and minimum daily pressures in each month are distinguished by being printed in strong figures.

Comparison with the corresponding tabulation from the barograms showed that the reading taken at 1879. December 2^{d} 14 was +·100 inch in error: this was allowed for.

* In the manner described in paragraph 54 of the Introduction of the preceding volume.

32. *Temperature of the Air, &c.*—The plan of the following tables is the same as that of Tables I, IX, XVII and XXV, but the subjects of them and the sources from which the numbers are obtained and the mode of obtaining them are as stated :—

Tables II, X, XVIII and XXVI.—Temperature of the air : derived from hourly tabulations of the thermograph dry-bulb.

Tables III, XI, XIX and XXVII.—Pressure of vapour : derived from hourly tabulations of the thermograph dry-bulb and wet-bulb, and of the barograph ; and calculated in the manner described in paragraph 23.

Tables IV, XII, XX and XXVIII.—Additional capacity of the air : derived from hourly differences between the pressure of vapour corresponding to the temperature of the air and the calculated actual pressure of vapour.

Tables VI, XIV, XXII and XXX.—Velocities of the north and east components of the wind : derived from hourly tabulations from the register of the Robinson-Beckly anemograph.

Tables VII, XV, XXIII and XXXI.—Velocity of the wind : derived from hourly tabulations from the register of the Robinson-Beckley anemograph.

Tables XXXIII, XXXVI, XXXIX and XLII.—Extent of cloudy sky : derived from estimations made at the hours 6, 10, 14, 16 and 22 daily.

33. Tables V, XIII, XXI and XXIX, and XXXIV, XXXV, XXXVII, XXXVIII, XL, XLI, XLIII and XLIV are on the same plan as Tables I, IX, XVII and XXV, except that the entries made in them are aggregates—daily, monthly and yearly—instead of mean values ; and they are sufficiently explained by their several headings.

34. *Monthly and annual range of variation of Meteorological Elements.*—Tables XLV to XLVIII show the extreme limits between which the oscillations of barometric pressure, temperature of the air, pressure of vapour, and additional capacity of the air were confined in each month and in each of the four years, and also the ranges of the respective oscillations.

35. The numbers in Tables VIII, XVI, XXIV and XXXII in which blanks imply the non-occurrence of the particular winds opposite which they are placed, are derived from hourly tabulations from the register of the Robinson-Beckley anemograph. The temperatures of the ground given in Tables XLIX to LII are derived from the readings of the several thermometers made five times a day as regards the 1 inch and 9 inches deep thermometers, and once a day as regards the 20 inches, 60 inches and 132 inches deep thermometers. The five-day means of Tables LIII to LVI are derived from hourly tabulations of the barograph (combined with readings of Newman's barometer No. 58) and thermograph : those of Table LVII from the measurements in Newman's gauge, and those in Tables LVIII and LIX from hourly tabulations from the register of the Robinson-Beckley anemograph. The rainfall of Table LX is that received in Newman's gauge. In other respects these, and in all respects the remaining Tables require no explanation beyond their titles, headings of the several columns, and the foot-notes.

Notes on Instrumental Changes and on irregularities or departures from the routine of observation or reduction, 1879 to 1882.

36. *Osler's Rain Gauge.*—In February 1882—*i. e.* in the middle of the dry season—the copper float was found to contain water to the extent of ·02 inch. This was discharged and the leak in the float was then soldered up.

37. *Robinson-Beckley Anemograph.*—Dismounted and cleaned and also cleaned the clock on March 7, 1880. External parts painted on July 10, 1879, March 12, 1880, May 26, 1881 and May 26, 1882. Clock stopped on September 22, 1879, April 18, 1881 and September 12, 1882: each time from the breaking of the suspension cord of the driving weight. Light stay-rods removed on May 27 and 29, 1879; and April 3, and May 25, 1882. The aggregates of all the interruptions of the instrument in the years 1879 to 1882 were $5^h\ 22^m$, $10^h\ 49^m$, $0^h\ 40^m$ and $3^h\ 33^m$ respectively: the loss of record was, however, rarely complete, and values, partly or entirely interpolated, have been inserted whenever the interruption was not somewhat prolonged. To aid in the making of interpolations, it has been customary, whenever the action of the instrument was voluntarily interrupted to observe the direction of the wind by estimation, and to record the readings of a small auxiliary velocity measurer put up for the occasion. No complete day's records have been omitted in the formation of monthly abstracts.

38. When for any reason the traces furnished by the photographic self-registering instruments are interrupted, and the interruption includes the moments when one or more hourly tabulations should be made, these last are either substituted by the corresponding eye-observations, if the hours should happen to be any of the five regular observation hours, or if special eye-observations were taken for the purpose, or else, if no eye-observations are available, they are interpolated. In the last case, if the interruption lasts for less time than one hour, the interpolation is made on the assumption that the rate of change of the phenomenon from its value at the beginning to its value at the end of the interruption was uniform, providing that the parts of the curve immediately preceding and immediately following the gap were, in appearance, continuations of the straight line connecting the extremities of the gap. If the last condition is not satisfied, or if the gap, taking account of points inserted by means of eye-observations, is of greater length than one hour, the interpolation is made between the next preceding and the next following hourly entries, first, by allowing for the known *normal* rate of change of the phenomenon between those hours in the same month, and then by assuming that any additional change, shown by the difference between the values of the phenomenon at the two extreme hours, has grown at a uniform rate. Interpolated values are entered in the abstract sheets with enclosing square brackets—inserted eye-observations between parentheses.

39. *Barograph.*—No tabulations were obtained for the following hours for the several reasons stated, but eye-observations were available and were adopted for the hours marked within parentheses, and for the rest interpolation had to be resorted to—

(1.) Owing to stoppages of the clock: for 1879, (January $10^d\ 6^h$), (June $14^d\ 16^h$), July $6^d\ 12^h$, $10^d\ 8^h$ and 9^h, and October $10^d\ 2^h$ to 4^h.

(2) Owing to failure of light: for 1879, (April $14^d\ 22^h$); and 1882, May $23^d\ 8^h$.

(3.) Owing to faulty waxed paper: for (1879, August $9^d\ 10^h$, 12^h and 13^h).

(4.) By inattention of operator: for (1882, January $12^d\ 10^h$).

The temperature curves of 1879, August 9^d 11^h, 1880, October 25^d 16^h and 1882, July 2^d 22^h and 3^d 6^h being lost or too faint to be made use of, the tabulations were made from imaginary straight lines filling up the several gaps; these tabulations will therefore be affected by temperature, but none of them to the extent of ·001 inch, since the ranges of temperature of the barograph on the several days were only 0°·4, 0°·1, 0°·6 and 0°·9 respectively, and the gaps were, in no case, so much as an hour in length.

Heating and cooling experiments were going on during 1879, February 13^d 6^h to 18^d 22^h; 1880, January 26^d 7^h to 27^d $11\frac{1}{2}^h$ and 30^d 11^h to 31^d $10\frac{1}{2}^h$ and 1881, January 7^d $10\frac{1}{2}^h$ to 10^d $18\frac{1}{2}^h$, January 31^d $22\frac{1}{2}^h$ to February 1^d $4\frac{1}{2}^h$ and February 24^d $6\frac{1}{2}^h$ to 27^d $6\frac{1}{2}^h$. As the temperature compensation has been found to be practically effective the tabulations were made for these times in the usual manner.

Occasional, though rare, failure of the bi-hourly stops to act has caused no loss of record.

The aggregate of all the interruptions of the barograph in the years 1879 to 1882 was 11^h 22^m,* the number of hourly tabulations lost was 14, but of these 7 were substituted by eye-observations, leaving only 7 to be interpolated.

40. *Thermograph—Dry-bulb.*—No tabulations were obtained for the following hours for the several reasons stated, but eye-observations were available, and were adopted for the hours marked within parentheses, and for the rest interpolation had to be resorted to:—

(1.) Owing to stoppage of clock; for 1879, October 14^d 2^h and 3^h and (30^d 10^h), November 11^d (11^h, 13^h, 14^h and 15^h); and 1881, August 9^d 23^h, and 14^d 3^h.

(2.) Clock being taken to pieces for cleaning; for 1881, August (28^d 12^h to 19^h).

(3.) Owing to failure of light: for 1880, December 12^d 5^h; 1881, April 11^d 9^h and (October 3^d 6^h); and 1882, April 19^d 12^h.

(4.) Owing to faulty waxed paper: for 1879, August 9^d (10^h), 11^h, (12^h) and (13^h).

(4*a*.) Owing to careless manipulation in photographic processes: 1882, July 26^d 9^h.

(5.) Five-degree lines on thermometer tube being filed deeper; for 1879, (March 18^d 13^h and 14^h).

(6.) Connection with clock-work of apparatus for closing the shutters every two hours altered so as to shut off the light at 26^m past the hour instead of at 0^m: (1881, January 2^d 10^h).

Occasional, though rare, failure of the bi-hourly stops to act has caused no loss of record.

The aggregate of all the interruptions of the thermograph-dry-bulb, in the years 1879 to 1882 was 26^h 7^m; the number of hourly tabulations lost was 29, and of these 20 were substituted by eye-observations, leaving 9 to be interpolated.

41. *Thermograph—Wet-bulb.*—No tabulations were obtained for the following hours for the several reasons stated, but eye-observations were available and were adopted for the hours marked within parentheses, and for the rest interpolation had to be resorted to:—

(1) Owing to stoppages of the clock: same as for dry-bulb.

(2) Clock being taken to pieces for cleaning: same as for dry-bulb.

* If not unusually prolonged, the short interruptions caused by the regular changing of photographic papers and by changing of lamps are not included in the above aggregate, nor in the aggregates of interruptions of the thermograph that follow further on.

(3) Owing to the failure of light; for 1879, July 12^d 4^h; and 1880 February 27^d (6^h).

(4) Owing to faulty waxed paper: same as for dry-bulb.

(5) Five-degree lines on the thermometer tube being filed deeper: for 1879, March 18^d (13^h).

(6) Connection with clockwork of apparatus for closing the shutters every two hours altered so as to shut off the light at 26^m past the hour instead of at 0^m? same as for dry-bulb.

(7) Drying of muslin covering of bulb and imperfect capillary action of threads: for 1880, February 11^d 13^h, (14^h), 15^h, (16^h) and 17^h, and 12^d (14^h), 15^h, (16^h) and 17^h.

Occasional, though rare, failure of the bi-hourly stops to act has caused no loss of record.

The aggregate of all the interruptions of the thermograph-wet-bulb, in the years 1879 to 1882 was 51^h 4^m; but the number of hourly tabulations lost was 34 and of these 23 were substituted by eye-observations, leaving 11 to be interpolated.

42. *Self-registering Rain-gauge.*—The copper pipe connecting the funnel with receiving vessel having become obstructed by cobwebs was under examination between 14^h and 15^h on the 28th May 1879 when a discharge took place through the syphon and its measurement was lost: the results of several experimental discharges (0·50 inch) was adopted.

Whilst changing the bottle between 2^h and 3^h on the 25th June 1879 a discharge took place of which no measurement could be made: the average value (0·52 inch) of the other discharges on that day was adopted for the lost one.

Comparison of the aggregate of the syphon discharges of 1879, July 30^d 10^h to 31^d 10^h (5·95 inches) with the fall measured by Newman's gauge led to a suspicion that the previous day's discharge (0·54) had been measured over again: as the syphon dribbled on both days the doubt could not be removed by the tabulations, and the fall adopted for the later day was 5·41 inches. Ordinarily the water is thrown away after measurement, but although the observer has no recollection of any departure from the regular usage, it is supposed that, finding the contents of the bottle on July 30^d 10^h to be excessive for a single discharge, he kept them for verification of the measurement and afterwards forgot all about it.

When through the faulty action of the syphon alluded to in paragraph 26, the water discharged has been considerably in excess of the equivalent of the actual number of emptyings of the vessel, the excess has been distributed uniformly over the time during which the faulty action seemed, on inspection of the pluviograms, to have lasted.

43. No tabulations were obtained for the hourly intervals succeeding the hours named below, for the several reasons stated:—

(1) Owing to stoppage of the sieve at the bottom of the rain-gauge funnel—the apertures having been covered with crows' droppings: for 1881, June 10^d 0^h to 11^d 9^h.

(2) From faulty action of the syphon, from which the water dribbled awhile before beginning to run: for 1879, May 27^d 3^h to 5^h, and 27^d 22^h to 28^d 5^h, June 28^d 15^h to 17^h, July 1^d 11^h and 12^h, 19^d 8^h and 9^h, 29^d 20^h and 21^h, and 30^d 21^h and 22^h; 1880, June 6^d 10^h and 11^h, and 24^d 4^h to 7^h and 12^h to 15^h, July 2^d 9^h and 10^h; 1881, June 6^d 15^h and 16^h, and 9^d 2^h to 4^h; and 1882, June 3^d

1^h and 2^h, and 12^d 3^h to 5^h, July 1^d 15^h and 16^h, 2^d 2^h, 3^h, 10^h and 11^h, and 19^d 8^h and 9^h, August 1^d 8^h and 9^h, September 9^d 22^h to 10^d 5^h, and 10^d 22^h to 11^d 5^h, and October 3^d 22^h to 4^d 2^h.

(3) From indistinctness of the curve: for 1879, August 9^d 9^h to 13^h.

II.—MAGNETICAL INSTRUMENTS.

Kew Absolute Declinometer and Deflection and Vibration Apparatus.

44. A description of this instrument, with which the observations of absolute declination and of horizontal intensity for the years 1879 to 1882 have been taken, will be found on pages xxxiii. to liii. of the Introduction to the "Bombay Magnetical and Meteorological Observations, 1865-70"; the description includes also an account of the situation of the instrument, of the nature and routine of the observations taken with it—with examples of observation and computation forms filled up with the figures of actual observations—and of the formulæ of reduction and the constants involved in them.

45. The entries in columns 1 to 16 and 18 of the Tables of Observations of Absolute Horizontal Force are copied directly from the computation form: column 17 is given to show the degree of accordance existing in the determinations from deflections with the deflecting magnet at the respective distances 0·8 foot and 1·0 foot from the deflected magnet; and the numbers in column 20 are the products of those in column 19 multiplied by the constant number ·46108.

46. The description, referred to above, of the observation of absolute declination, will render clear the meaning of the numbers entered in each column of the Tables of Observations of Absolute Declination: all of these except the monthly means, in columns 12 and 13, are taken directly from the observation form.

Kew Dip Circle.

47. A description of this instrument and of the mode of using it is also given in the Introduction to the "Bombay Magnetical and Meteorological Observations, 1865-70," pages lvi. to lix, and the following additional or corrective remarks will make it applicable to the observations of 1879 to 1882:—

(1) The place of observation has been the top room of the Electrometer Tower, the dip circle having been placed on the same pillar on which the Kew Unifilar magnetometer is placed in the regular observations of absolute horizontal force and absolute declination. The reading of the azimuth circle adopted for this place has invariably been 63° 31′. An observation for the verification of this reading was made on the 22nd February 1881.

(2) On 1881 October 8-10, the instrument was taken to pieces and thoroughly cleaned and readjusted.

(3) The dip needles used have been as follows:—
From 1879, January 3 to 1881, November 25...Adie No. 5.
From 1881, October 4 and 7 to 1882, December 26 and 29...
John Dover No. $\frac{1}{81}$ and John Dover No. 2.

(4) The final cleaning of the axles of the needles has throughout been made with a clean silk cloth.

(5) 1881, October 10—One of the agate planes was lowered a little to bring it down to the same level as the other.

CHARLES CHAMBERS.

Colaba Observatory,
May 1883.

TABLES OF RESULTS

DERIVED

FROM THE CONTINUOUS REGISTRATIONS OF AUTOMATIC METEOROLOGICAL INSTRUMENTS

AND FROM

METEOROLOGICAL OBSERVATIONS.

1879 to 1882.

TABLES OF RESULTS

DERIVED FROM THE

METEOROLOGICAL OBSERVATIONS MADE DAILY AT 6, 10, 14, 16, AND 22 HOURS.

1879 to 1882.

FIVE-DAY MEANS.

1879 to 1882.

825—1 R

Table I.—Barometric Pressure, 1879.

Height of Barometer above mean Sea level = 37 feet.

1879.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	29·932	29·977	29·839	29·804	29·746	29·666	29·621	29·634	**29·673**	29·882	**29·779**	29·932
2	·953	·971	·883	·770	·748	·699	·630	·641	·704	·800	·796	·931
3	·953	·934	**·925**	·754	·717	·722	·668	·618	·731	·786	·815	·921
4	**·973**	·965	·897	·809	·729	·734	·688	·597	·738	·784	·830	·907
5	·967	**30·008**	·853	·796	·742	·721	·689	·591	·757	·753	·869	·899
6	·940	29·957	·865	·774	·743	·737	·660	**·589**	·767	**·734**	·885	·893
7	·926	·926	·893	·771	·742	·788	·644	·649	·813	·763	·881	·892
8	·933	·902	·912	·798	·753	**·790**	·638	·703	·836	·767	·897	·900
9	·926	·914	·886	·786	·772	·768	·640	·707	·809	·765	·930	·896
10	·916	·929	·875	·788	·750	·761	·653	·703	·753	·767	·934	·921
11	·939	·950	·866	·771	**·790**	·743	·670	·668	·766	·814	·912	·930
12	·949	·936	·823	·755	·782	·736	·727	·665	·815	·840	·919	·891
13	·924	·943	·791	·783	·774	·735	**·766**	·704	·847	·831	·951	·835
14	·915	·928	·848	·829	·776	·740	·765	·719	·820	·848	·947	**·828**
15	·920	·896	·870	·849	·741	·727	·737	·683	·812	·860	·897	·872
16	·919	·878	·879	·786	·744	·655	·707	·672	·792	·867	·885	·908
17	·891	·835	·872	·778	·709	·635	·721	·711	·803	·869	·905	·928
18	·875	·828	·882	·797	·676	·642	·729	·741	·795	·902	·909	·920
19	**·872**	·835	·845	·799	·681	·631	·733	·736	·774	**·919**	·869	·900
20	·884	·825	**·780**	·805	·668	·588	·707	·707	·755	·903	·845	·916
21	·894	·847	·819	·862	·601	·588	·681	·716	·732	·906	·885	**·934**
22	·922	·814	·900	**·864**	·506	·599	·711	·734	·769	·898	·911	·933
23	·912	**·794**	·862	·848	**·402**	·595	·719	·740	·814	·860	·943	·910
24	·900	·834	·834	·813	·440	·602	·713	·720	·843	·851	·940	·864
25	·906	·860	·852	·796	·559	·617	·704	·687	·835	·845	·915	·877
26	·936	·861	·892	·825	·592	·605	·689	·689	·820	·804	·870	·913
27	·942	·868	·903	·799	·551	**·539**	·650	·705	·801	·788	·888	·911
28	·920	·864	·872	**·752**	·567	·587	·631	**·758**	·846	·830	·966	·923
29	·890		·825	·763	·605	·662	·613	·735	·896	·869	**·977**	·907
30	·938		·809	·767	·624	·649	**·586**	·681	**·917**	·847	·946	·883
31	·973		·814		·636		·591	·661		·806		·897
Monthly Means	**29·924**	29·895	29·860	29·796	**29·673**	29·675	29·680	29·686	29·794	29·831	29·897	29·902
Annual Variation ...	+·123	+·094	+·059	—·005	—·128	—·126	—·121	—·115	—·007	+·030	+·096	+·101

	in.
The greatest mean daily barometric pressure in the year (that of 5th February) was	30·003
The least do. do. do. (that of 23rd May) was	29·402
Difference =	0·601

TABLE II.—Temperature of the Air, 1879.

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	76·3	75·5	77·0	83·4	83·3	82·7	79·8	79·3	79·4	80·0	78·8	71·9
2	75·9	75·4	75·7	82·0	83·9	83·0	81·1	78·6	79·7	80·2	**79·1**	73·3
3	74·5	74·7	73·8	81·1	83·1	82·8	81·6	77·6	79·7	80·2	77·9	72·4
4	75·7	75·5	**73·1**	81·7	83·3	83·2	80·4	77·8	79·5	79·5	76·1	72·2
5	76·1	75·1	74·2	81·1	83·2	83·2	80·9	77·2	80·3	79·9	77·0	72·9
6	75·2	76·7	74·9	81·1	84·4	83·1	81·7	78·2	79·7	80·1	77·0	74·4
7	74·8	76·3	75·9	81·2	83·8	**84·0**	82·0	80·0	79·6	78·1	77·1	**76·5**
8	73·8	74·9	76·4	80·0	83·7	83·9	82·2	79·5	80·3	79·5	76·9	76·1
9	73·0	74·2	77·8	80·5	82·5	83·8	82·2	78·5	80·6	80·1	78·6	74·7
10	**71·6**	72·7	79·3	81·2	82·6	83·9	82·2	80·3	80·0	80·9	77·4	72·5
11	72·4	72·4	80·4	81·1	82·9	84·0	82·5	80·4	80·3	81·4	76·9	72·1
12	72·9	**72·2**	78·5	81·7	83·1	82·8	82·5	**80·5**	79·6	81·3	76·2	72·4
13	73·7	73·1	77·9	81·4	83·3	81·9	**82·6**	79·0	79·3	80·8	76·7	73·0
14	75·0	74·3	78·4	81·4	83·8	83·0	81·9	77·7	**80·8**	81·2	77·2	74·5
15	74·6	73·4	77·2	80·0	84·7	83·3	82·2	78·8	80·4	81·0	76·4	75·6
16	74·6	72·8	78·9	**79·8**	84·4	81·8	82·4	79·0	79·8	79·6	75·5	72·8
17	74·1	73·6	79·9	81·2	82·9	**79·5**	82·6	78·7	79·7	80·3	75·9	71·8
18	75·7	76·4	81·2	81·5	82·9	79·8	80·0	79·2	79·7	80·3	76·4	71·9
19	75·1	77·1	78·5	80·1	83·6	80·8	79·9	77·2	78·7	**81·6**	75·2	73·0
20	74·4	75·6	77·7	80·5	84·1	81·3	81·7	77·6	79·3	81·0	75·8	74·3
21	73·2	74·0	78·4	81·7	83·6	81·7	81·9	78·8	79·7	80·1	77·6	75·6
22	74·5	74·8	78·5	80·6	83·8	82·0	79·7	77·4	79·5	80·9	77·5	75·4
23	76·0	75·2	80·7	80·9	**87·5**	81·8	81·5	78·1	77·6	80·9	76·7	73·3
24	75·8	76·7	82·1	83·2	81·1	80·6	81·8	**77·0**	78·9	81·3	73·0	72·7
25	77·5	76·9	80·6	**83·8**	**77·1**	79·5	82·2	78·6	78·7	79·4	72·5	71·4
26	**77·8**	77·0	80·7	83·3	79·4	79·7	82·0	79·2	79·0	77·6	73·2	**70·6**
27	75·7	78·6	81·0	82·5	81·2	80·4	80·6	79·7	**77·1**	77·9	75·6	71·1
28	75·4	**78·9**	80·8	82·4	80·4	80·9	80·7	80·4	78·0	**77·0**	75·1	71·3
29	75·3		80·1	82·4	80·6	81·3	81·4	79·9	78·2	77·3	73·2	71·6
30	75·6		81·5	82·6	82·4	81·2	79·6	79·6	78·8	78·3	**71·5**	72·9
31	76·3		**83·8**		82·6		**77·9**	79·3		78·0		73·0
Monthly Means	74·9	75·1	78·5	81·5	**82·9**	82·0	81·3	78·8	79·4	79·9	76·1	**73·1**
Annual Variation	—3·7	—3·5	—0·1	+2·9	+4·3	+3·4	+2·7	+0·2	+0·8	+1·3	—2·5	—5·5

The greatest mean daily temperature of the air in the year (that of 23rd May) was ... ... 87·5
The least do. do. do. (that of 26th December) was ... 70·6

Difference = 16·9

Table III.—Pressure of Vapour, 1879.

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·653	0·554	0·636	0·746	0·897	**0·960**	0·881	0·859	0·858	0·863	0·652	0·520
2	·535	·554	·605	·702	·902	·953	·914	·854	·835	·904	·785	·508
3	·504	·560	·532	·741	·888	·937	**·919**	·855	·806	**·929**	**·793**	·571
4	·579	·643	·463	·806	·884	·931	·899	·863	·826	·892	·748	·560
5	·630	·628	·497	·833	·882	·925	·912	·862	·831	·902	·786	·598
6	·644	·614	·618	·855	·864	·928	·909	·867	·832	·895	·754	·618
7	·618	·535	·667	·808	·859	·929	·896	·876	·823	·876	·678	·597
8	·584	·504	·716	·738	**·789**	·907	·902	·873	·812	·885	·652	·592
9	·582	·600	·725	**·687**	·894	·893	·908	·869	·808	·878	·556	·540
10	·589	·526	·709	·707	·894	·889	·909	·888	·808	·890	·579	·435
11	·604	**·468**	·663	·751	·854	·896	·895	**·905**	·816	·843	·580	**·400**
12	·616	·502	·773	·778	·889	·886	·897	·897	·829	·855	·584	·435
13	·628	·614	·797	·858	·904	·891	·897	·868	·811	·853	·565	·522
14	·670	·635	·774	·785	·918	·880	·888	·846	·812	·856	·602	·584
15	**·671**	·559	·652	·809	·945	**·859**	·882	·857	·801	·840	·636	·541
16	·538	·503	·638	·806	·944	·884	·876	·867	·794	·798	·672	·533
17	·548	·551	·581	·852	·906	·876	·856	·864	·791	·785	·641	·565
18	·613	·696	**·424**	·715	·896	·890	**·841**	·874	·804	·792	·557	·578
19	·564	**·711**	·481	·742	·913	·914	·862	·848	·824	·761	·566	·553
20	·512	·636	·561	·732	·911	·928	·856	·857	**·869**	·795	·625	·567
21	**·498**	·623	·777	·697	·933	·916	·846	**·842**	·869	·812	·671	·571
22	·563	·595	**·818**	·729	·967	·915	·860	·844	·795	·752	·645	·514
23	·558	·600	·785	·788	·931	·920	·883	·851	·783	·745	·584	·541
24	·567	·647	·722	·823	·855	·921	·888	·845	**·766**	·718	·538	·539
25	·577	·681	·773	·841	·863	·906	·887	·848	·779	·696	·532	·605
26	·580	·697	·779	**·893**	·903	·891	·889	·844	·777	·674	·548	·604
27	·558	·672	·737	·843	·905	·904	·900	·870	·790	·684	·533	·620
28	·527	·679	·709	·850	·891	·917	·886	·888	·819	·695	·457	**·651**
29	·542		·749	·887	·917	·922	·917	·869	·815	·646	**·434**	·568
30	·591		·747	·883	**1·009**	·905	·873	·862	·831	**·551**	·488	·544
31	·545		·738		0·970		·867	·850		·591		·532
Monthly Means	0·580	0·600	0·672	0·790	0·903	**0·909**	0·887	0·863	0·814	0·795	0·615	**0·552**
Annual Variation ...	—0·168	—0·148	—0·076	+0·042	+0·155	+0·161	+0·139	+0·115	+0·066	+0·047	—0·133	—0·196

	in.
The greatest mean daily pressure of vapour in the year (that of 30th May) was	1·009
The least do. do. do. (that of 11th December) was	0·400
Difference =	0·609

TABLE IV.—Additional capacity of the Air, 1879.

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·259	0·334	0·295	**0·402**	0·245	0·157	0·136	0·142	0·146	0·162	0·336	0·269
2	·367	·330	·285	·395	·260	·178	·148	·124	·179	·128	·212	·322
3	·357	·303	·303	·323	·247	·187	·161	·091	·208	·102	·165	·233
4	·319	·245	359	·280	·259	·207	·140	·089	·181	·118	·155	·235
5	·275	·251	·356	·231	·257	·211	·144	·103	·203	·121	**·143**	·215
6	·232	·309	·256	**·209**	·320	·207	·174	·100	·181	·132	·177	·236
7	·249	**·376**	·236	·260	·301	·240	·197	·147	·188	**·087**	·257	·321
8	·255	·367	·195	·290	·371	·256	·201	·136	·222	·124	·279	·316
9	·233	·250	·231	·358	·217	·266	·191	·104	·236	·150	**·430**	·324
10	**·187**	·279	·295	·365	·225	·275	·191	·147	·216	·166	·371	·367
11	·194	·332	·380	·316	·274	·272	·215	·132	·219	·228	·354	**·394**
12	·197	·296	·206	·308	·248	·239	·212	·143	·184	·214	·329	·368
13	·207	**·208**	·166	·218	·238	·200	·218	·122	·192	·199	·362	·296
14	·202	·219	·199	·292	·242	·250	·200	·105	**·240**	·210	·340	·279
15	·190	·265	·284	·216	·249	**·282**	·219	·127	·237	·218	·280	·353
16	·324	·308	·357	·214	·238	·203	·232	·124	·225	·214	·214	·274
17	·302	·284	·443	·217	·220	·133	**·258**	·116	·224	·256	·259	·215
18	·282	·220	**·651**	·363	·230	·130	·183	·123	·213	·248	·359	·211
19	·313	·223	·501	·287	·237	·138	·161	·085	·163	·327	·318	·265
20	·341	·250	·398	·313	·262	·138	·227	·089	**·133**	·267	·275	·289
21	·327	·220	·198	·390	·220	·168	·245	·143	·145	·221	·281	·324
22	·301	·273	**·160**	·316	·195	·180	·155	·096	·214	·310	·303	·374
23	·350	·277	·268	·271	**·383**	·165	·197	·112	·163	·313	·341	·288
24	·336	·275	·379	·319	·210	·125	·196	**·083**	·223	·359	·278	·273
25	·375	·245	·274	·319	**·069**	**·101**	·216	·130	·204	·314	·273	·168
26	**·381**	·235	·271	·247	·102	·123	·205	**·155**	·214	·277	·276	·147
27	·337	·309	·326	·270	·163	·134	·146	·146	·141	·278	·364	·146
28	·359	·313	·345	·259	·147	·138	·162	·151	·143	·242	·421	**·118**
29	·339		·282	·223	·129	·145	·157	·152	·151	·295	·393	·213
30	·301		·336	·231	·099	·160	·138	·149	·155	**·423**	·293	·272
31	·370		·426		·143		**·090**	·151		·371		·284
Monthly Mean	0·292	0·278	**0·312**	0·290	0·226	0·187	0·184	**0·123**	0·191	0·228	0·295	0·271
Annual Variation.	+0·052	+0·038	+0·072	+0·050	—0·014	—0·053	—0·056	—0·117	—0·049	—0·012	+0·055	+ 0·031

	in.
The greatest mean daily additional capacity of the air in the year (that of 18th March) was ...	... 0·651
The least do. do. do. (that of 25th May) was ...	... 0·069
Difference=	0·582

Rainfall, 1879.

TABLE V.—*Total Fall of Rain (in inches) as measured by F. Chambers' Self-registering Gauge, the funnel of which is 28 feet above the ground.*

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	November	December
			in.		in.	in.	in.	in.	in.	in.		
1							0·63	0·48	0·30	0·09		
2						0·10	0·19	1·25	0·06			
3						0·05	0·04	1·52		0·03		
4						0·04	0·42	**2·42**	0·03			
5						0·17	0·14	1·65	0·01			
6						0·06	0·01	1·02	0·21			
7								0·04		0·23		
8								0·57				
9							0·01	0·78	0·02			
10							0·02	0·07	0·10			
11							0·03	0·20	0·01			
12						0·07		0·06				
13						1·48	0·08	0·15	0·37			
14						0·07	0·14	1·06	0·01			
15							0·16	0·66	0·04			
16						1·09		0·35	0·03			
17						1·82		0·57				
18						1·16	0·05	0·88				
19						1·29	0·34	0·82	0·25			
20						0·12		0·48	0·57			
21					0·17			0·24	**1·40**			
22					0·08	0·02	0·54	1·56				
23						0·20		0·51	0·46			
24					0·02	**3·86**	0·15	2·24	0·01			
25					0·54	2·06	0·01	0·17	0·03			
26			0·02		1·48	1·22		0·08				
27					0·44	0·59	0·05	0·26	0·43			
28					1·77	0·39	0·01	0·15	0·29			
29					0·16	0·06	0·36	0·43	0·30			
30					0·01	0·14	**3·60**	0·44	0·43			
31							3·32	0·29				
Monthly Total			0·02		4·67	16·06	16·30	**21·40**	5·36	0·35		
No. of rainy days			1		9	22	22	31	22	3		

Total fall of rain in the year ... ... 58·16 inches.

Total number of rainy days in the year 110

The greatest daily fall of rain in the year (that of 24th June) was ... ... 3·86 inches.

No rain fell in the months of January, February, April, November, and December, nor on any of the days left blank in the above table.

The entries for May 27 and 28, bracketed together, are correct in the aggregate, but only approximate in the distribution.

Mean Daily Velocities of the North and East Components of the Wind, 1879.

TABLE VI.—*Showing the Mean Velocities of the North or South and East or West Components of the Winds which blew on each Day of the year* 1879.

In Miles per Hour.

1879.	MONTH.																							
Date.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.
1 ...	6·2 N	1·2 E	9·6 N	2·6 W	14·6 N	10·6 W	12·1 N	7·2 W	4·0 N	5·6 W	7·3 S	9·9 W	10·3 S	18·1 W	2·4 S	17·6 W	3·7 N	13·1 W	10·0 N	8·1 W	6·1 N	1·2 W	7·6 N	1·9 E
2 ...	6·8 N	5·6 E	9·7 N	3·7 W	12·5 N	8·5 W	12·0 N	6·7 W	1·3 S	6·3 W	11·7 S	7·8 W	8·6 S	21·2 W	0·3 S	16·4 W	1·6 S	19·0 W	9·2 N	6·6 W	0·9 N	1·6 W	5·7 N	5·1 E
3 ...	2·4 N	3·0 E	6·4 N	3·0 W	12·1 N	6·8 W	9·2 N	5·7 W	3·9 N	6·5 W	13·6 S	6·9 W	8·1 S	18·7 W	5·8 S	13·8 W	4·1 S	16·4 W	5·4 N	1·7 W	1·6 N	3·4 W	3·2 N	1·6 E
4 ...	7·0 N	2·1 E	3·1 N	0·2 W	15·2 N	5·4 W	0·3 S	3·8 W	0·1 S	6·0 W	9·7 S	6·8 W	5·0 S	19·1 W	1·7 S	19·2 W	2·9 S	14·1 W	4·5 S	0·0	2·8 N	2·5 W	3·3 N	1·0 E
5 ...	7·8 N	0·2 W	6·6 N	2·3 W	7·3 N	3·2 W	2·2 S	4·8 W	1·4 N	6·4 W	8·8 S	9·0 W	6·2 S	17·2 W	2·8 S	19·2 W	0·6 S	14·6 W	15·5 S	0·3 W	2·9 N	2·0 W	5·9 N	0·8 E
6 ...	6·4 N	1·2 W	10·4 N	3·9 W	5·4 N	4·1 W	4·3 S	3·6 W	9·0 N	8·3 W	6·5 S	11·4 W	3·2 S	17·2 W	1·3 S	22·9 W	0·0	10·6 W	14·2 S	1·6 E	3·5 N	0·5 W	6·9 N	1·3 E
7 ...	8·5 N	2·5 W	12·3 N	4·0 W	8·8 N	4·9 W	0·9 S	6·7 W	10·7 N	9·2 W	4·3 S	10·1 W	1·6 S	17·5 W	4·0 S	21·8 W	0·3 N	7·2 W	17·1 S	1·4 E	7·3 N	0·6 E	4·7 N	3·0 E
8 ...	7·8 N	3·2 W	8·9 N	3·8 W	11·7 N	6·0 W	7·8 N	7·8 W	8·7 N	7·5 W	1·8 S	8·1 W	7·4 S	12·8 W	7·3 S	18·7 W	0·2 S	8·0 W	12·7 S	0·4 E	8·0 N	0·1 W	5·6 N	3·0 E
9 ...	5·5 N	3·5 W	5·4 N	2·9 W	9·3 N	4·6 W	12·7 N	8·9 W	7·7 N	7·3 W	1·1 N	8·1 W	11·5 S	13·1 W	7·5 S	19·7 W	0·0	12·7 W	1·0 N	3·0 W	8·7 N	6·3 E	6·1 N	0·5 E
10 ...	1·8 N	0·3 W	6·6 N	2·8 W	8·7 N	5·0 W	12·5 N	7·8 W	4·7 N	5·8 W	7·2 N	10·8 W	9·6 S	15·1 W	5·3 S	20·6 W	0·3 N	16·6 W	4·2 N	3·1 W	6·9 N	4·1 E	12·7 N	2·2 W
11 ...	1·0 N	0·1 W	12·4 N	3·4 W	11·8 N	6·4 W	10·1 N	7·8 W	3·7 N	5·7 W	9·1 N	12·6 W	6·7 S	18·6 W	7·5 S	18·1 W	2·9 S	12·0 W	4·4 N	5·7 W	6·8 N	4·8 E	11·8 N	6·7 E
12 ...	3·5 N	1·2 W	6·3 N	3·0 W	10·6 N	7·4 W	8·1 N	9·0 W	12·7 N	8·3 W	9·8 N	7·6 W	3·0 S	16·6 W	8·3 S	20·0 W	6·2 S	4·7 W	7·4 N	3·4 W	6·5 N	2·6 E	11·1 N	6·1 E
13 ...	5·0 N	1·6 W	4·3 N	2·7 W	3·6 N	4·7 W	8·0 N	8·3 W	9·2 N	9·1 W	6·4 N	10·5 W	0·3 S	15·0 W	5·6 S	18·1 W	0·2 S	10·9 W	9·6 N	1·3 W	8·9 N	5·3 E	7·8 N	3·1 E
14 ...	5·0 N	2·0 W	5·4 N	2·9 W	4·7 N	4·9 W	5·6 N	6·4 W	7·0 N	8·5 W	5·2 N	11·4 W	0·3 N	16·0 W	5·3 S	21·3 W	0·9 N	16·1 W	8·8 N	2·6 W	8·2 N	3·7 E	6·5 N	4·5 E
15 ...	6·6 N	2·3 W	9·5 N	5·5 W	12·9 N	8·3 W	6·0 N	6·7 W	11·4 N	12·4 W	4·0 S	8·2 W	2·0 S	15·6 W	7·3 S	24·1 W	0·6 N	10·5 W	4·8 N	0·7 W	4·0 N	0·6 E	7·6 N	7·9 E
16 ...	12·9 N	4·2 W	10·3 N	1·6 W	17·8 N	6·8 W	6·6 N	6·7 W	2·7 S	7·1 W	6·5 S	7·7 W	2·2 S	15·7 W	6·6 S	20·3 W	2·3 N	5·6 W	6·8 N	1·1 W	4·5 N	0·6 W	4·3 N	4·3 E
17 ...	8·7 N	1·9 W	2·0 N	0·8 W	15·9 N	7·3 W	2·9 N	4·6 W	6·6 N	7·6 W	11·1 S	2·9 W	0·4 S	11·4 W	5·4 S	14·3 W	3·6 N	3·3 W	5·6 N	0·9 E	6·2 N	1·4 W	4·7 N	1·3 E
18 ...	6·0 N	1·6 E	5·7 S	1·5 W	16·5 N	1·9 W	3·6 N	6·9 W	0·8 N	7·1 W	6·4 S	8·2 W	4·0 S	4·6 W	1·4 S	15·6 W	4·9 N	4·2 W	8·3 N	1·9 E	6·6 N	2·9 E		
19 ...	8·7 N	3·2 W	0·3 S	4·8 W	16·6 N	7·9 W	2·0 N	6·5 W	2·0 N	8·0 W	7·8 S	1·4 W	3·8 S	0·5 W	0·3 S	10·4 W	3·5 N	8·9 W	8·6 N	2·0 E	9·2 N	0·3 E	6·8 N	0·4 E
20 ...	10·8 N	2·8 W	5·3 N	3·7 W	8·9 N	4·9 W	4·8 S	6·5 W	7·5 N	11·4 W	11·8 S	3·4 E	2·2 N	6·8 W	6·8 S	4·6 W	7·8 N	7·2 W	4·3 N	1·5 W	8·5 N	1·4 E	9·2 N	0·1 W
21 ...	9·5 N	1·5 W	7·8 N	1·6 W	4·9 S	3·6 W	2·9 S	8·6 W	6·9 N	8·5 W	19·4 S	4·4 E	0·3 S	7·6 W	4·5 S	11·1 W	8·4 N	7·2 W	4·9 N	1·3 W	5·4 N	1·8 E	9·0 N	2·0 E
22 ...	7·3 N	0·9 E	2·3 N	1·6 W	2·9 S	3·5 W	4·8 N	7·2 W	4·0 N	4·5 W	16·8 S	1·7 E	5·2 N	0·4 E	3·6 S	11·2 W	2·7 N	7·2 W	6·8 N	1·1 W	9·1 N	1·2 W	10·0 N	4·1 E
23 ...	9·4 N	3·2 E	1·0 N	1·5 W	6·5 N	2·8 W	11·7 N	7·8 W	1·8 N	7·0 E	13·6 S	3·6 W	4·9 N	2·3 W	1·3 N	12·0 W	2·9 N	2·8 W	8·6 N	1·2 W	11·3 N	1·5 W	7·1 N	1·8 E
24 ...	7·9 N	0·7 E	0·4 N	0·7 W	7·1 N	2·5 W	10·6 N	7·3 W	20·1 S	32·2 E	16·3 S	6·9 W	8·7 N	4·0 W	1·1 N	11·3 W	6·4 N	5·3 W	7·2 N	3·8 E	10·2 N	2·6 W	2·0 N	0·9 E
25 ...	8·1 N	1·1 E	5·8 N	3·8 W	6·9 N	5·9 W	3·5 N	6·0 W	29·1 S	17·5 E	6·6 S	26·6 W	9·2 N	7·2 W	2·6 S	14·2 W	6·8 N	5·4 W	6·9 N	0·6 W	9·4 N	1·9 W	9·0 N	1·7 W
26 ...	10·1 N	0·1 W	4·0 N	3·5 W	7·4 N	6·0 W	4·3 S	3·5 W	21·8 S	5·4 E	9·5·8	24·6 W	7·3 N	5·0 W	4·4 S	12·5 W	6·0 N	9·6 W	7·4 N	0·8 W	9·5 N	1·6 W	10·9 N	2·7 W
27 ...	11·9 N	2·2 W	9·2 N	3·6 W	12·8 N	8·0 W	3·6 N	7·1 W	4·0 S	0·4 E	2·3 S	26·4 W	3·3 N	1·0 E	11·7 S	6·3 W	4·9 N	7·9 W	6·8 N	1·1 E	9·8 N	5·4 E	7·3 N	0·4 W
28 ...	12·0 N	2·5 W	14·7 N	7·7 W	16·1 N	7·6 W	2·4 N	5·8 W	1·4 N	1·4 E	0·0	26·0 W	0·1 S	3·7 W	6·1 S	9·7 W	1·3 S	6·9 W	6·4 N	1·1 W	10·3 N	7·7 E	12·7 N	3·0 W
29 ...	10·2 N	2·6 W			8·2 N	6·7 W	0·3 N	6·9 W	5·1 S	0·8 E	1·1 S	20·6 W	3·3 S	3·7 W	0·0	16·6 W	2·7 S	3·7 W	8·9 N	2·0 E	8·1 N	7·7 E	11·4 N	1·5 W
30 ...	8·6 N	2·1 W			11·1 N	6·2 W	3·7 N	6·1 W	2·5 S	5·8 W	8·5 S	21·0 W	1·9 N	12·9 W	3·1 N	14·3 W	0·4 N	2·6 W	10·3 N	0·8 E	7·0 N	3·1 E	10·2 N	2·8 E
31 ...	9·3 N	2·0 W			19·8 N	8·9 W			2·7 S	10·6 W			2·0 N	19·8 W	6·5 N	14·3 W			7·7 N	1·5 W			7·3 N	2·5 E
Monthly Mean ...	7·5 N	0·7 W	6·2 N	2·9 W	10·1 N	5·8 W	4·7 N	6·6 W	1·2 N	3·8 W	5·5 S	10·2 W	1·7 S	11·5 W	3·7 S	15·8 W	1·5 N	9·1 W	3·7 N	1·1 W	7·0 N	1·2 E	7·6 N	1·9 E
Annual Variation ...	4·3 N	4·7 E	3·0 N	2·5 E	6·9 N	0·4 W	1·5 N	1·2 W	2·0 S	1·6 E	8·7 S	4·8 W	4·9 S	6·1 W	6·9 S	10·4 W	1·7 S	3·7 W	0·5 N	4·3 E	3·8 N	6·6 E	4·4 N	7·3 E

The Velocities of the Mean Components for the year are 3·2 N. and 5·4 W.

Velocity of Wind, 1879.

TABLE VII.—*Mean Velocity of the Wind, in miles per hour, without regard to the direction from which it blew, for each Day of Bombay Civil Time: also the Mean Monthly Velocity, and its Variation from the Mean of the Year.*

1879.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles
1...	9·5	11·4	18·8	14·7	8·1	12·7	21·8	18·1	14·0	13·2	8·5	10·0
2...	13·2	11·2	15·7	14·7	9·5	14·3	**23·1**	16·9	**19·3**	11·5	6·6	11·6
3...	10·7	8·0	14·8	12·1	8·6	15·7	20·4	16·0	17·2	9·5	6·6	8·0
4...	11·0	9·0	17·3	9·8	8·6	12·4	20·0	19·7	14·7	**6·2**	**5·2**	7·5
5...	9·4	8·9	9·9	**7·4**	8·2	13·0	18·4	19·7	14·7	16·1	6·5	9·2
6...	7·7	12·0	8·6	9·4	13·7	13·4	17·8	23·1	11·1	15·3	7·3	9·8
7...	10·3	13·8	11·2	12·9	14·9	11·0	17·8	22·6	7·3	**17·7**	9·9	10·0
8...	9·2	10·5	13·5	11·6	13·6	8·6	15·0	20·4	8·1	13·5	10·4	10·4
9...	8·2	7·8	11·6	**16·8**	12·3	**8·3**	17·7	21·6	12·7	7·2	13·8	10·1
10...	**5·2**	9·7	11·3	15·5	9·6	13·2	18·3	21·7	17·1	7·4	12·4	14·4
11...	5·4	14·2	14·0	14·2	9·0	15·8	19·9	19·6	13·6	7·4	12·0	**17·7**
12...	8·0	8·8	13·7	14·2	16·7	14·1	17·2	21·6	10·1	9·4	11·5	15·5
13...	7·2	6·8	8·1	13·9	14·6	14·8	15·1	19·2	11·3	11·8	13·5	11·2
14...	7·2	8·8	**7·7**	10·8	12·8	13·1	16·1	22·3	16·3	10·1	12·8	11·3
15...	7·9	12·0	15·8	9·8	17·1	10·0	16·0	**25·6**	10·6	7·4	7·2	14·1
16...	**14·4**	13·5	21·0	11·9	13·2	11·8	16·2	21·6	7·2	8·3	7·3	8·0
17...	10·2	7·1	18·3	7·7	10·5	13·9	11·5	15·7	7·5	7·8	8·7	7·0
18...	10·0	9·2	18·1	8·6	7·8	11·5	10·5	15·9	7·8	9·4	11·5	10·6
19...	10·2	6·1	19·2	7·6	8·4	10·6	7·9	11·4	10·2	10·9	12·3	9·2
20...	12·7	8·0	10·9	8·6	14·0	14·1	7·8	**9·7**	11·1	6·2	11·2	10·4
21...	11·1	9·5	10·0	9·6	12·2	21·1	7·7	13·1	11·9	8·2	9·9	10·8
22...	9·8	6·5	7·7	9·8	8·9	18·6	7·8	12·5	7·7	8·6	10·7	13·6
23...	13·0	6·0	9·9	15·0	16·5	16·3	9·0	13·4	**5·9**	10·7	12·7	9·7
24...	10·4	**5·6**	11·4	14·1	**39·5**	20·2	11·0	12·1	9·5	11·5	11·5	**6·8**
25...	11·3	8·6	12·2	11·0	35·1	**28·2**	12·4	14·7	10·7	9·1	11·2	11·2
26...	12·1	7·5	10·6	13·5	23·2	26·5	10·3	13·4	11·5	9·6	10·6	11·8
27...	13·7	10·9	16·0	10·5	10·2	26·8	**5·3**	13·5	9·9	10·4	13·5	9·2
28...	13·1	**17·4**	18·0	9·6	6·7	26·0	8·0	11·8	8·3	8·7	**16·1**	13·3
29...	11·6		11·2	9·2	8·0	20·8	8·5	16·6	6·9	13·5	14·9	12·5
30...	10·0		14·5	8·1	**6·6**	22·8	15·1	15·0	6·7	13·1	10·2	13·6
31...	10·7		**22·0**		11·4		20·4	15·7		10·0		11·7
Monthly Mean ...	10·1	**9·6**	13·6	11·4	13·2	16·0	14·3	**17·2**	11·0	10·3	10·6	11·0
Annual Variation .	−2·3	−2·8	+1·2	−1·0	+0·8	+3·6	+1·9	**+4·8**	−1·4	−2·1	−1·8	−1·4

	Miles.
The Mean Velocity for June to August	15·8
The Mean Velocity for September to May	11·2
The Mean Velocity for the Year	12·4
The greatest monthly mean (that of August)	17·2
The least monthy mean (that of February)	9·6
Difference =	7·6

The greatest mean daily Velocity of Wind in the year (that of 24th May) was	39·5
The least do. do. do. (that of 19th January) was	5·2
Difference =	34·3

Aggregate and Mean Velocities and Relative Frequency of Different Winds, 1879.

TABLE VIII.—*Showing, for the year 1879, the sum of the Velocities, and the Mean Velocities, in miles per hour, of the Winds which blew in each Month, from each of the sixteen Principal Directions; and also the number of Observations which those sums comprise; the latter numbers indicating the Relative Frequency of the same Wind (as to direction) in the several Months, and of different Winds during the same Month.*

1879.	N.			NNE.			NE.			ENE.			E.			ESE.			SE.			SSE.		
MONTH.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	979	120	8·2	582	94	6·2	982	119	8·3	497	50	9·9	238	35	6·8	147	18	8·2	0	0	...	0	0	...
February ...	806	100	8·1	421	70	6·0	159	25	6·4	261	36	7·2	116	22	5·3	189	29	6·5	57	8	7·1	32	2	16·0
March ...	1084	121	9·0	220	29	7·6	212	25	8·5	54	10	5·4	47	9	5·2	14	3	4·7	22	2	11·0	87	10	8·7
April ...	291	41	7·1	318	41	7·8	32	8	4·0	19	3	6·3	25	5	5·0	38	7	5·4	30	5	6·0	271	21	12·9
May ...	188	37	5·1	172	25	6·9	217	20	10·8	120	10	12·0	165	8	20·6	417	23	18·1	1150	39	29·5	668	26	25·7
June ...	43	3	14·3	21	2	10·5	14	2	7·0	0	0	...	0	0	...	7	2	3·5	329	21	15·7	746	37	20·2
July ...	34	7	4·9	142	21	6·8	123	18	6·8	83	10	8·3	13	2	6·5	103	17	6·1	87	8	10·9	49	4	12·2
August ...	0	0	...	0	0	...	0	0	...	0	0	...	0	0	...	0	0	...	0	0	...	0	0	...
September ...	46	6	7·7	36	9	4·0	38	8	4·7	29	4	7·2	9	2	4·5	49	10	4·9	54	9	6·0	54	6	9·0
October ...	398	61	6·5	327	57	5·7	836	106	7·9	443	49	9·0	59	13	4·5	86	12	7·2	42	6	7·0	572	40	14·3
November ...	568	69	8·2	460	71	6·5	1150	123	9·3	1622	133	12·2	180	27	6·6	113	15	7·5	0	0	...	8	2	4·0
December ...	729	84	8·7	387	55	7·0	1521	137	11·1	1610	147	11·0	347	42	8·3	72	9	8·0	0	0	...	0	0	...
Year ..	5166	649	8·0	3086	474	6·5	5284	591	8·9	4738	452	10·5	1199	165	7·3	1235	145	8·5	1771	98	18·1	2487	148	16·8

1879.	S.			SSW.			SW.			WSW.			W.			WNW.			NW.			NNW.		
Months.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	0	0	...	0	0	...	2	1	2·0	0	0	...	10	1	10·0	473	50	9·5	1379	112	12·3	2261	142	15·9
February ...	12	1	12·0	21	2	10·5	23	3	7·7	122	19	6·4	224	37	6·1	407	42	9·7	2220	176	12·6	1388	99	14·0
March ...	70	7	10·0	102	12	8·5	35	4	8·7	97	15	6·5	98	13	7·5	396	44	9·0	3745	221	16·9	3875	219	17·7
April ...	187	19	9·8	201	23	8·7	187	24	7·8	430	47	9·1	566	71	8·0	1653	135	12·2	2689	181	14·9	1186	89	13·3
May ...	596	32	18·6	140	16	8·8	170	22	7·7	378	38	9·9	680	79	8·6	1861	150	12·4	2337	169	13·8	575	50	11·5
June ...	608	33	18·4	1531	97	15·9	1288	105	12·3	2896	171	16·9	2366	128	18·5	947	71	13·3	585	39	15·0	135	9	15·0
July ...	102	9	11·3	45	5	9·0	996	57	17·5	3941	219	18·0	3472	237	14·6	431	40	10·8	865	71	12·2	170	19	8·9
August ...	101	6	16·8	383	28	13·7	454	42	10·8	6211	338	18·4	4717	262	18·0	811	55	14·7	114	10	11·4	32	3	10·7
September...	137	14	9·8	58	6	9·7	10	2	5·0	1096	86	12·7	3429	276	12·4	1362	139	9·8	1346	124	10·9	197	19	10·4
October ...	679	47	14·4	381	32	11·9	29	4	7·2	5	1	5·0	31	4	7·7	259	28	9·2	1785	155	11·5	1742	128	13·6
November ...	0	0	...	24	6	4·0	23	4	5·7	18	3	6·0	43	5	8·6	318	32	9·9	1156	106	10·9	1915	124	15·4
December ...	0	0	...	0	0	...	0	0	...	25	4	6·2	24	4	6·0	233	27	8·6	747	69	10·8	2475	165	15·0
Year...	2492	168	14·8	2886	227	12·7	3217	268	12·0	15219	941	16·2	15660	1117	14·0	9151	813	11·2	18968	1433	13·2	15951	1066	15·0

TABLE IX.—Barometric Pressure, 1880.

Height of Barometer above mean Sea level = 37 feet.

1880. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	29·883	29·936	29·898	29·791	29·704	29·598	29·625	29·701	29·784	29·864	29·913	**29·903**
2	·834	·921	·912	·748	·751	·607	·631	·679	·751	·863	·907	·925
3	**·792**	·918	·899	·772	·768	**·580**	·617	·625	·726	·860	·903	·962
4	·796	·919	·886	·749	·764	·604	·652	·619	·739	·871	·880	·936
5	·847	·893	·917	**·742**	·769	·611	·705	·623	·748	·891	·883	·930
6	·873	·895	**·966**	·757	·813	·682	·722	**·585**	·759	·866	·891	·965
7	·850	·877	·928	·749	**·828**	·729	·678	·614	·750	·848	·923	·949
8	·862	·901	·870	·745	·816	·705	·687	·694	·836	·880	·971	·951
9	·880	·927	·857	·761	·822	·686	·696	·738	**·920**	·861	·950	·960
10	·915	·913	·879	·780	·797	·683	·666	·752	·854	·822	·935	·985
11	·917	·903	·886	·777	·787	·671	·667	·770	·704	·829	·944	·985
12	·905	·845	·862	·812	·781	·679	·680	·790	·689	·829	·937	30·000
13	·897	**·835**	·825	·786	·769	·665	·609	·786	·736	·812	·963	·024
14	·896	·864	·805	·799	·752	·646	**·561**	·789	·742	·794	**·976**	**·033**
15	·923	·849	·803	·756	·760	·643	·585	·791	·708	·772	·945	·032
16	·908	·858	·813	·808	·749	·678	·616	·786	**·641**	·788	·924	·004
17	·886	·902	·825	·828	·767	·702	·641	·761	·691	·787	·916	29·988
18	·915	·918	·849	·828	·750	·736	·672	·727	·739	·796	·920	·972
19	·936	·898	·803	·795	·729	**·747**	·703	·757	·757	·794	·918	·974
20	·963	·896	·758	·802	·723	·725	·752	·794	·765	·769	·866	·953
21	·964	·934	**·738**	·820	·736	·726	**·770**	·810	·790	**·760**	**·836**	·963
22	·972	·947	·784	·813	·752	·716	·722	·800	·814	·788	·892	·960
23	·958	·963	·841	·821	·766	·717	·683	·806	·823	·843	·906	·976
24	·957	**·978**	·848	·810	·742	·707	·700	·826	·826	·888	·876	·997
25	·993	·969	·871	·788	·727	·688	·739	·838	·820	·920	·856	30·003
26	30·002	·963	·841	·748	·727	·661	·739	**·843**	·818	·922	·874	29·995
27	29·957	·916	·809	·781	·730	·638	·725	·828	·826	·907	·905	30·000
28	·961	·913	·787	**·857**	·718	·615	·752	·824	·849	·920	·904	·005
29	·985	·902	·792	·837	·669	·609	·760	·809	·854	**·928**	·912	29·958
30	·996		·810	·752	·613	·598	·751	·782	·849	·925	·897	·954
31	**30·003**		·801		**·580**		·720	·785		·928		·971
Monthly Mean.	29·917	29·909	29·844	29·787	29·747	**29·668**	29·685	29·753	29·777	29·849	29·911	**29·975**
Annual Variation ...	+·099	+·091	+·026	−·031	−·071	−·150	−·133	−·065	−·041	+·031	+·093	+·157

	in.
The greatest mean daily barometric pressure in the year (that of 14th December) was ...	30·033
The least do. do. do. (that of 14th July) was	29·561
Difference =	0·472

Table X.—Temperature of the Air, 1880.

1880. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December
	°	°	°	°	°	°	°	°	°	°	°	°
1	72·3	76·7	77·5	84·3	84·7	85·4	79·6	79·4	**80·9**	**79·4**	**82·2**	78·7
2	71·2	75·5	76·6	**86·1**	84·1	**86·0**	77·0	80·1	80·8	80·2	81·1	**79·8**
3	**70·6**	74·3	**76·0**	85·0	84·1	85·3	80·2	79·2	80·1	80·2	80·1	79·0
4	71·5	73·6	77·8	82·5	84·2	84·3	79·7	79·0	80·0	80·6	79·9	78·6
5	72·5	73·1	79·1	**81·3**	84·0	84·9	**76·8**	79·9	80·2	80·2	79·8	78·5
6	74·1	72·9	79·3	81·9	83·8	81·9	77·8	78·9	80·1	81·5	79·2	78·9
7	75·5	73·0	80·4	82·6	83·8	84·2	78·2	78·9	79·4	82·8	81·9	78·2
8	74·3	73·3	81·5	82·2	**83·4**	85·2	80·0	79·8	80·3	82·8	81·9	78·2
9	73·8	71·6	80·0	82·3	83·6	85·2	81·1	79·4	80·5	83·3	81·6	77·5
10	73·2	70·7	79·2	82·4	83·5	85·3	**81·5**	79·2	78·8	84·0	81·3	77·1
11	70·8	69·8	78·2	82·6	83·7	85·4	81·4	78·8	78·1	**84·2**	80·3	75·9
12	70·7	70·1	78·5	82·2	84·8	85·5	80·1	79·5	78·0	83·2	80·0	75·2
13	70·8	72·4	77·7	83·3	84·5	85·3	80·5	79·5	78·5	82·4	79·7	75·2
14	72·5	73·2	77·9	84·3	83·9	85·3	80·7	79·8	78·6	82·1	79·7	75·4
15	74·2	73·3	78·7	84·7	83·9	85·3	80·5	79·9	77·4	81·6	79·0	75·1
16	73·8	73·4	79·0	84·3	84·0	85·2	81·2	**78·6**	78·0	80·3	77·8	74·5
17	73·7	70·4	78·4	83·5	84·2	85·1	81·3	80·2	77·7	80·2	77·9	74·6
18	73·3	**67·6**	79·0	83·1	84·4	85·0	81·3	80·6	79·1	80·2	77·2	**74·4**
19	72·3	69·2	80·3	83·9	84·9	84·9	80·9	80·5	78·6	80·9	77·1	76·0
20	71·4	71·9	81·4	83·5	**85·8**	84·9	81·2	80·5	76·9	80·8	**76·7**	76·8
21	72·0	73·3	82·0	83·4	85·5	84·9	79·3	80·0	77·7	80·3	79·6	76·8
22	73·4	73·5	82·3	82·9	85·3	83·9	79·8	78·9	**76·2**	81·0	80·3	77·1
23	72·7	73·0	81·9	81·8	85·4	81·8	79·4	79·6	78·3	79·9	80·1	76·9
24	75·5	73·4	80·9	82·2	84·7	**77·0**	77·0	80·3	79·1	80·2	80·6	77·4
25	**76·1**	73·4	83·6	82·5	84·6	78·0	78·7	80·4	80·1	80·1	79·0	77·5
26	75·5	73·4	**84·6**	83·0	84·6	78·0	80·3	80·4	79·8	79·5	78·5	76·7
27	73·8	74·9	83·0	83·3	85·1	77·5	79·9	80·5	80·1	80·2	79·2	77·7
28	73·0	77·2	83·6	84·1	85·4	79·0	80·7	80·8	80·6	80·6	80·3	77·3
29	74·0	**78·7**	83·3	83·8	85·1	79·6	80·3	80·2	80·1	80·7	79·6	76·4
30	75·6		82·8	84·2	85·3	79·0	81·0	**80·9**	79·6	81·5	79·4	75·9
31	75·4		81·9		85·4		80·3	80·9		83·4		75·9
Monthly Mean	73·2	**73·0**	80·2	83·2	**84·5**	83·3	79·9	79·8	79·1	81·2	79·7	76·9
Annual Variation ...	−6·3	−6·5	+0·7	+3·7	+5·0	+3·8	+0·4	+0·3	−0·4	+1·7	+0·2	−2·6

	°
The greatest mean daily temperature of the air in the year (that of 2nd April) was	86·1
The least do do do (that of 18th February) was	67·6
Difference =	18·5

Table XI.—Pressure of Vapour, 1880.

1880. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·545	0·581	0·652	0·776	0·890	0·911	0.889	0·823	**0·795**	0·842	0·809	0·686
2	·541	·602	·688	·780	·849	·926	·859	·844	·797	·877	·760	·717
3	**·428**	·613	·679	·829	·841	**·955**	**·895**	·868	·809	·873	·678	·690
4	·438	·605	·691	·776	·845	·874	·887	**·890**	·826	·906	·669	·689
5	·553	·479	·727	·801	·853	·949	·848	·877	·838	·893	·645	·727
6	·599	·454	·832	·828	·846	·949	·875	·863	·829	·911	·683	**·755**
7	·629	·480	·691	·827	·821	·938	·855	·830	·833	·950	**·579**	·699
8	·644	·527	**·624**	·815	·812	·901	·864	·822	·828	**·964**	·601	·679
9	·608	·558	·638	·833	**·806**	·902	·863	·835	·839	·944	·711	·685
10	·617	·422	·660	·864	·824	·895	·870	·818	·839	·915	·790	·681
11	·610	**·379**	·748	·880	·841	·881	·873	·836	·852	·904	·798	·664
12	·618	·419	·789	·851	·869	·895	·875	·836	·849	·840	·809	·633
13	·629	·586	·731	·800	·852	·890	·873	·822	·868	**·781**	·783	·677
14	·629	·634	·740	·790	·826	·882	·869	·823	·849	·819	·670	·659
15	·645	·613	·784	·879	·828	·891	·857	·811	·847	·842	·652	·626
16	**·680**	·559	·822	**·954**	·861	·881	·867	**·799**	**·877**	·788	·667	·656
17	·643	·443	·803	·925	·846	·898	·878	·821	·875	·787	·689	·659
18	·616	·392	·818	·875	·861	·886	·873	·818	·871	·875	·719	·572
19	·608	·383	·856	·882	·868	·898	·870	·819	·861	·916	·711	·611
20	·592	·524	**·883**	·884	·877	·898	·862	·811	·819	·872	·673	·666
21	·608	·557	·868	·831	·870	·886	·841	·808	·818	·903	·702	·636
22	·645	·580	·854	·758	·865	·885	·841	·803	·828	·878	·704	·593
23	·469	·616	·852	**·708**	·864	·876	·833	·825	·807	·854	·731	·622
24	·454	**·637**	·835	·777	·846	·822	·847	·817	·796	·836	·811	·588
25	·491	·606	·848	·842	·857	**·820**	·842	·812	·806	·816	**·830**	**·537**
26	·430	·590	·786	·841	·866	·834	·844	·801	·818	·798	·784	·555
27	·492	·512	·788	·852	·891	·847	·838	·807	·830	·825	·711	·606
28	·513	·528	·761	·921	**·898**	·890	·854	·808	·838	·844	·776	·608
29	·546	·580	·762	·921	·882	·907	·834	·807	·812	·849	·720	·613
30	·545		·834	·916	·886	·877	·843	·820	·817	·877	·648	·593
31	·579		·868		·897		**·832**	·806		·836		·607
Monthly Mean.	0·569	**0·533**	0·771	0·841	0·856	**0·891**	0·860	0·825	0·832	0·865	0·717	0·645
Annual Variation ...	−0·198	−0·234	+0·004	+0·074	+0·089	+0·124	+0·093	+0·058	+0·065	+0·098	−0·050	−0·122

	in.
The greatest mean daily pressue of vapour in the year (that of 8th October) was	0·964
The least do. do. do. (that of 11th February) was ...	0·379
Difference =	0·585

TABLE XII.—Additional Capacity of the Air, 1880.

1880. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·253	0·346	0·296	0·409	**0·304**	0·309	0·123	0·180	**0·261**	0·164	0·294	0·300
2	·226	·283	·231	**·475**	·326	·319	**·070**	·186	·256	·157	·306	·307
3	·329	·237	·224	·380	·329	·262	·139	·129	·219	·160	·356	·305
4	·339	·225	·268	·337	·331	·306	·129	**·101**	·197	·142	·361	·294
5	·251	·341	·274	·269	·317	·255	·074	·146	·195	·141	·380	·253
6	·252	·354	·173	·265	·316	·143	·077	·124	·199	·168	·321	·234
7	·262	·338	·353	·291	·341	·236	·108	·158	·170	·175	**·522**	·270
8	·208	·300	**·453**	·287	·336	·310	·165	·195	·208	·157	·495	·291
9	·231	·219	·385	·274	·347	·311	·198	·171	·205	·195	·373	·263
10	·203	·332	·341	·246	·326	·320	·207	·182	·150	·253	·282	·251
11	·146	·355	·220	·236	·316	**·341**	·199	·150	·113	·273	·237	·234
12	·138	·325	·187	·249	·329	·328	·152	·171	·110	·302	·222	·246
13	**·129**	·216	·223	·341	·334	·327	·168	·186	·107	**·331**	·236	**·201**
14	·176	**·186**	·219	·389	·339	·834	·179	·196	·130	·279	·351	·226
15	·204	·211	·203	·317	·335	·324	·183	·209	·094	·238	·348	·248
16	·159	·264	·173	**·226**	·307	·333	·197	·180	·083	·248	·290	·201
17	·194	·302	**·171**	·227	·329	·312	·192	·211	·076	·248	·268	·202
18	·210	·288	·176	·260	·322	·319	·197	·228	·124	·160	·217	·286
19	·189	·343	·180	·285	·335	·303	·185	·222	·120	·140	·223	·293
20	·181	·263	·191	·267	**·360**	·305	·202	·232	·108	·182	·250	·261
21	·181	·266	·230	·317	·358	·314	·162	·218	·131	**·133**	·315	·288
22	·182	·248	·251	·370	·352	·277	·175	·185	**·075**	·183	·334	·344
23	·342	·199	·240	·382	·357	·211	·171	·186	·162	·166	·299	·308
24	·439	·189	·220	·327	·348	·108	·079	·216	·199	·196	·235	·359
25	·420	·218	·305	·271	·335	·140	·142	·228	·221	·213	**·161**	**·413**
26	**·465**	·236	·405	·292	·326	·126	·191	·237	·199	·210	·191	·371
27	·352	·359	·346	·291	·319	**·096**	·182	·233	·197	·207	·290	·350
28	·306	**·417**	·398	·249	·322	·100	·194	·243	·207	·200	·262	·332
29	·303	·411	·387	·239	·330	·107	·199	·226	·216	·200	·292	·300
30	·349		·293	·258	·330	·114	**·217**	·235	·195	·201	·360	·305
31	·306		·225		·325		·202	**·248**		·313		·294
Monthly Mean.	0·256	0·285	0.266	0·301	**0·332**	0·253	**0·163**	0·194	0·164	0·204	0·302	0.285
Annual Variation.	+0·006	+0·035	+0·016	+0·051	+0·082	+0·003	−0·087	−0·056	−0·086	−0·046	+0·052	+0·035

	in.
The greatest mean daily additional capacity of the air in the year (that of 7th November) was	0·522
The least do. do do. (that of 2nd July) was ...	0·070
Difference=	0·452

Rainfall, 1880.

TABLE XIII.—*Total Fall of Rain (in inches) as measured by F. Chambers's Self-registering Gauge, the funnel of which is 28 feet above the ground.*

1880.	MONTH.											
DATE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
			in.			in.	in.	in.	in.	in.		
1							0·37	0·12	0·09			
2							**7·96**	0·10				
3						0·24	1·03	0·28	0·02			
4							0·24	0·14	0·18			
5						1·72	4·20	0·19	0·25	0·05		
6			0·01			2·06	0·31	0·38	0·17			
7						0·08	0·52	0·06	0·55			
8							0·21	0·05	0·10			
9						0·14	0·10	0·02				
10							0·03	0·49	2·71			
11								0·17	**3·75**			
12							0·38	0·03	0·32			
13							0·15	0·04	2·61			
14							0·01	0·08	1·41			
15							0·02		0·62			
16							0·01	0·20	2·44			
17						0·04	0·05	0·10	2·39			
18						0·01			0·18			
19							0·11	0·01	1·98	0·01		
20							0·03		0·19	0·09		
21							0·49	0·48		0·83		
22						0·06	0·02	**0·50**	0·96			
23						0·31	0·01	0·14	0·17			
24						**4·76**	0·41	0·03				
25						2·45	0·60					
26						1·31	0·04		0·74			
27						3·98	0·07	0·01	0·01			
28						1·36	0·02	0·07				
29						1·35	0·07	0·10				
30						0·93	0·01					
31							0·10					
Monthly Total.			0·01			20·80	17·57	3·79	**21·84**	0·98		
No. of rainy days.			1			16	**29**	24	22	4		

Total fall of rain in the year ... ... 64·99 inches.
Total number of rainy days in the year 96
The greatest daily fall of rain in the year (that of 2nd July) was ... ... 7·96 inches.

No rain fell in the months of January, February, April, May, November and December, nor on any of the days left blank in the above table.

Mean Daily Velocities of the North and East Components of the Wind, 1880.

TABLE XIV.—*Showing the Mean Velocities of the North or South and East or West Components of the Winds which blew on each day of the year* 1880.

In Miles per Hour.

1880.	MONTH.																							
Date.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.
1 ...	10·1 N	0·1 W	6·9 N	0·1 E	4·3 N	1·8 W	13·1 N	4·8 W	1·2 S	6·6 W	1·7 N	7·6 W	21·1 S	3·9 W	5·9 S	20·8 W	1·7 N	5·3 W	9·9 N	5·6 W	5·5 N	0·4 E	7·5 N	1·2 W
2 ...	8·6 N	1·0 W	10·1 N	2·6 W	4·9 N	3·8 W	15·9 N	6·4 W	3·6 S	7·6 W	1·9 N	7·8 W	4·3 S	22·2 W	4·4 S	13·4 W	1·0 N	8·2 W	8·0 N	1·8 W	4·8 N	0·5 E	9·0 N	2·7 E
3 ...	11·5 N	1·6 W	15·1 N	5·3 W	7·1 N	2·6 W	4·0 N	7·8 W	0·4 N	7·6 W	1·4 S	5·0 W	4·8 S	21·3 W	5·6 S	7·3 W	0·1 N	4·4 W	3·3 N	1·8 E	8·9 N	2·2 E	10·0 N	1·5 E
4 ...	9·0 N	1·9 E	11·7 N	4·5 W	3·2 N	0·7 W	1·0 N	5·8 W	0·7 S	6·8 W	5·7 S	1·8 W	1·5 N	20·5 W	6·2 S	7·0 W	0·6 S	13·1 W	2·1 S	0·8 E	8·1 N	4·4 E	7·6 N	0·4 E
5 ...	7·0 N	1·1 E	12·5 N	2·8 W	2·7 S	0·3 E	2·6 N	3·5 W	0·6 S	6·9 W	6·4 S	3·6 W	2·0 S	16·6 W	6·2 S	12·8 W	4·9 S	17·4 W	0·5 S	2·8 E	9·6 N	4·2 E	6·4 N	0·5 W
6 ...	6·5 N	0·7 E	12·7 N	3·3 W	2·1 S	3·0 W	2·8 S	5·4 W	4·9 N	6·8 W	5·0 S	2·7 W	5·1 S	4·3 W	2·6 S	18·2 W	1·6 S	17·1 W	3·6 N	0·6 E	8·4 N	1·2 E	5·8 N	1·0 E
7 ...	6·9 N	1·8 E	12·1 N	2·8 W	8·6 N	1·3 W	3·0 S	4·9 W	8·7 N	9·1 W	1·2 S	13·7 W	0·8 S	13·7 W	0·8 S	20·7 W	1·0 S	22·6 W	2·9 N	0·7 W	9·3 N	5·1 E	3·6 N	1·0 E
8 ...	3·6 N	0·3 E	11·8 N	3·5 W	11·6 N	3·8 W	0·1 S	4·3 W	7·4 N	8·9 W	3·4 S	14·0 W	0·8 S	10·5 W	6·5 S	17·9 W	5·4 S	15·0 W	1·4 S	1·7 W	9·0 N	5·9 E	4·7 N	0·9 E
9 ...	5·8 N	0·8 E	13·2 N	3·4 W	14·6 N	5·0 W	6·9 N	6·3 W	4·9 N	8·0 W	6·3 S	15·2 W	0·6 S	16·3 W	2·5 S	17·1 W	1·8 N	8·2 W	5·2 N	4·0 W	8·7 N	0·2 E	1·4 N	1·6 E
10 ...	7·1 N	1·6 W	14·6 N	3·7 W	10·4 N	5·6 W	6·6 N	8·0 W	8·2 N	9·3 W	4·4 S	15·0 W	2·3 S	23·9 W	6·7 S	14·4 W	10·1 N	6·7 W	5·6 N	2·1 W	8·1 N	0·6 W	4·0 N	0·6 E
11 ...	7·4 N	3·1 W	12·4 N	2·8 W	1·1 S	3·4 W	3·6 N	5·9 W	7·1 N	10·0 W	3·9 S	14·6 W	2·1 S	21·6 W	3·5 S	11·7 W	14·0 N	8·1 W	4·5 N	1·5 W	6·1 N	1·2 W	7·3 N	0·9 W
12 ...	8·6 N	3·5 W	8·8 N	2·2 W	1·8 S	4·0 W	4·5 N	5·7 W	2·8 N	7·6 W	3·4 S	13·3 W	3·5 S	22·0 W	3·3 S	10·4 W	9·0 N	6·9 W	7·0 N	1·1 W	4·1 N	1·4 W	7·4 N	0·8 W
13 ...	11·2 N	3·0 W	2·3 N	2·2 W	5·9 N	6·2 W	10·3 N	6·1 W	9·4 N	11·7 W	3·0 S	13·5 W	5·9 S	24·0 W	1·5 S	10·4 W	0·7 N	6·0 W	8·8 N	1·3 E	3·2 N	0·9 W	5·7 N	1·6 W
14 ...	5·9 N	0·6 W	1·1 S	0·9 E	8·9 N	5·9 W	11·7 N	8·3 W	5·7 N	8·6 W	3·4 S	12·7 W	6·4 S	29·6 W	3·0 S	12·5 W	6·4 N	10·9 W	9·2 N	3·8 W	4·1 N	5·0 E	7·7 N	1·9 W
15 ...	1·2 N	1·1 E	1·5 N	1·0 W	2·6 S	4·5 W	15·2 N	7·2 W	3·4 N	8·5 W	4·9 S	16·4 W	7·9 S	26·2 W	3·2 S	16·4 W	4·3 S	12·4 W	8·8 N	1·8 W	4·8 N	5·7 E	9·4 N	2·2 W
16 ...	5·0 N	2·1 W	2·9 N	2·3 W	3·4 S	3·2 W	1·8 S	5·7 W	4·4 N	8·1 W	1·1 S	20·0 W	9·3 S	22·4 W	0·1 S	15·5 W	0·0	16·1 W	7·7 N	1·3 W	4·8 N	1·6 E	8·6 N	2·1 W
17 ...	6·3 N	2·5 W	14·8 N	9·7 W	0·8 S	4·9 W	0·9 S	5·7 W	5·2 N	8·9 W	0·0	19·5 W	5·8 S	17·5 W	0·0	18·0 W	4·3 S	13·8 W	5·4 N	0·6 W	7·6 N	0·1 W	7·8 N	2·3 E
18 ...	8·3 N	2·9 W	12·7 N	0·5 E	2·3 N	6·4 W	0·4 S	6·8 W	3·4 N	6·2 W	0·0	14·5 W	6·6 S	15·8 W	0·8 S	21·8 W	4·4 S	8·8 W	1·5 S	0·7 W	3·6 N	4·0 W	9·9 N	0·7 W
19 ...	6·5 N	2·3 W	10·9 N	2·7 W	0·8 S	3·5 W	4·2 S	6·2 W	0·8 S	9·3 W	3·6 N	13·5 W	5·0 S	14·3 W	0·3 S	17·7 W	4·1 S	4·9 W	6·2 S	0·3 E	1·9 S	0·7 W	7·9 N	2·3 E
20 ...	10·2 N	0·9 W	12·7 N	3·9 W	8·5 S	4·1 W	1·2 S	7·0 W	5·5 S	8·9 W	0·3 N	12·4 W	4·9 S	14·4 W	1·4 S	14·5 W	11·7 S	3·1 E	0·8 N	0·1 W	8·8 N	1·1 W	5·0 N	0·3 E
21 ...	11·1 N	2·4 W	12·2 N	4·3 W	8·7 S	4·3 W	0·3 S	6·2 W	4·6 S	7·2 W	0·2 S	10·3 W	0·5 S	17·4 W	2·8 S	12·4 W	16·5 S	0·7 W	2·7 N	0·9 E	8·3 N	6·2 E	6·9 N	0·1 E
22 ...	11·7 N	3·8 W	8·6 N	5·0 W	6·8 S	7·4 W	1·9 N	6·5 W	1·4 N	8·8 W	1·0 S	9·7 W	1·2 N	18·0 W	2·8 S	11·7 W	7·9 S	0·5 W	16·9 S	6·2 E	12·0 N	7·4 E	7·3 N	0·7 E
23 ...	12·9 N	1·8 W	3·0 N	3·5 W	0·4 S	7·0 W	5·7 N	7·8 W	4·1 N	9·8 W	5·5 N	7·7 W	1·1 N	13·1 W	2·4 S	10·6 W	2·1 N	1·0 W	16·1 S	5·3 E	7·7 N	0·5 E	6·5 N	0·7 W
24 ...	11·7 N	6·1 E	0·6 N	0·1 W	2·4 N	4·8 W	4·4 N	6·2 W	4·9 N	10·0 W	3·9 N	7·5 W	1·2 N	4·0 W	0·1 N	9·0 W	5·1 N	5·4 W	11·2 S	0·6 E	4·1 N	8·5 E	6·1 N	5·6 E
25 ...	10·9 N	5·4 E	8·5 N	5·8 W	5·7 N	4·1 W	4·7 N	6·7 W	6·7 N	9·7 W	0·4 S	20·3 W	1·8 S	12·5 W	1·8 N	9·1 W	7·0 N	8·9 W	7·1 S	2·6 W	3·6 N	0·5 W	9·2 N	5·9 E
26 ...	11·9 N	8·1 E	12·2 N	4·6 W	9·2 N	6·4 W	8·0 N	8·3 W	6·8 N	9·7 W	5·6 S	18·3 W	4·5 S	21·9 W	2·5 N	9·0 W	4·1 N	11·8 W	2·1 S	0·7 W	7·9 N	1·5 W	6·4 N	0·7 E
27 ...	6·1 N	2·8 E	13·1 N	3·7 W	10·1 N	7·2 W	4·5 N	7·1 W	6·0 N	9·4 W	4·6 S	18·8 W	6·6 S	22·8 W	3·6 N	9·7 W	4·0 N	10·9 W	4·2 N	3·5 W	9·9 N	0·8 W	6·3 N	2·0 E
28 ...	5·5 N	2·1 E	10·2 N	0·6 E	10·6 N	6·1 W	0·6 N	7·0 W	4·7 N	9·2 W	11·8 S	11·5 W	8·2 S	21·2 W	2·3 N	8·0 W	7·6 N	12·7 W	4·2 N	2·7 W	7·2 N	0·7 E	3·6 N	1·2 E
29 ...	4·1 N	0·5 E	7·4 N	0·6 E	9·7 N	6·2 W	0·4 N	4·9 W	7·0 N	9·6 W	3·9 S	13·6 W	7·0 S	19·6 W	4·8 N	5·0 W	12·1 N	10·5 W	5·6 N	2·0 W	7·1 N	1·0 E	6·2 N	1·2 E
30 ...	3·8 N	3·0 E			2·6 S	5·5 W	2·0 S	5·8 W	4·5 N	9·6 W	4·1 S	12·2 W	7·7 S	18·0 W	5·5 N	6·0 W	10·4 N	7·2 W	6·6 N	3·3 W	5·1 N	1·4 E	8·3 N	0·8 W
31 ...	6·8 N	0·3 W			3·3 N	6·3 W			3·8 N	8·2 W			4·7 S	20·2 W	5·8 N	7·2 W			6·5 N	0·9 E			7·6 N	0·4 W
Monthly Mean ...	7·8 N	0·1 E	9·5 N	2·9 W	2·9 N	4·5 W	3·6 N	6·3 W	3·5 N	8·6 W	2·3 S	12·2 W	4·4 S	17·7 W	1·5 S	12·8 W	1·0 N	9·1 W	1·8 N	0·6 W	6·6 N	1·6 E	6·8 N	0·6 E
Annual Variation ...	4·9 N	6·1 E	6·6 N	3·1 E	0·0	1·5 E	0·7 N	0·3 W	0·6 N	2·6 W	5·2 S	6·2 W	7·3 S	11·7 W	4·4 S	6·8 W	1·9 S	3·1 W	1·1 S	5·4 E	3·7 N	7·6 E	3·9 N	6·6 E

The Velocities of the Mean Components for the year are 2·9 N and 6·0 W.

Velocity of Wind, 1880.

TABLE XV.—*Mean Velocity of the Wind, in miles per hour, without regard to the direction from which it blew, for each Day of Bombay Civil Time: also the Mean Monthly Velocity, and its Variation from the Mean of the year.*

1880.	MONTH.											
DATE.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November	December.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
1	12·6	8·7	7·3	15·5	9·6	8·5	23·0	**22·1**	**6·9**	12·7	8·5	9·4
2	10·5	11·8	8·1	17·3	9·3	**8·2**	23·9	14·3	8·9	10·0	8·5	12·8
3	13·0	16·2	9·5	12·4	7·8	13·6	22·5	10·0	7·6	8·3	12·0	12·4
4	12·2	13·6	7·0	8·3	**7·2**	10·6	20·9	11·0	13·5	6·2	11·8	8·8
5	10·5	13·5	8·4	7·7	7·4	12·5	17·5	14·8	18·4	7·0	12·6	8·3
6	9·6	13·5	8·2	7·4	8·7	11·9	11·9	18·9	17·5	7·7	11·2	9·2
7	10·3	13·1	9·8	8·0	13·0	14·1	15·5	21·0	**23·0**	6·3	11·1	7·5
8	**7·0**	13·0	12·9	8·4	12·3	14·8	12·6	19·2	16·2	8·2	11·9	8·5
9	9·6	14·5	**15·6**	11·2	10·1	16·4	16·6	17·8	8·9	7·0	10·4	**7·0**
10	8·7	15·7	12·3	11·2	13·6	15·8	24·3	16·2	12·6	7·3	10·7	9·4
11	9·1	13·5	8·0	8·9	12·5	15·4	22·0	12·5	17·2	6·5	8·6	9·1
12	10·2	10·0	**6·6**	8·4	8·7	14·0	22·7	11·1	13·2	8·7	6·4	9·2
13	12·4	7·4	8·9	13·7	**15·3**	14·1	25·2	10·7	10·0	11·2	6·6	7·9
14	7·8	7·9	11·2	15·6	10·6	13·4	**30·8**	13·1	13·2	10·7	12·1	9·5
15	7·0	7·4	8·7	**17·7**	9·4	17·4	27·8	17·0	14·5	9·7	10·5	11·2
16	7·2	8·6	8·4	12·1	10·5	20·2	24·2	16·0	16·7	9·6	7·5	10·2
17	7·8	**18·7**	7·6	10·4	10·9	19·5	18·7	18·0	15·5	8·5	9·8	11·8
18	10·0	16·4	7·2	8·1	8·0	14·5	17·1	22·0	11·0	**5·5**	**6·0**	11·4
19	9·0	12·5	8·9	9·3	9·9	14·2	15·4	17·7	12·0	10·1	7·2	11·9
20	11·5	14·2	11·9	7·5	10·7	12·4	15·5	14·7	13·0	6·1	11·0	9·0
21	12·4	13·6	12·0	8·0	9·6	10·6	17·9	13·2	18·5	10·0	13·5	9·1
22	12·9	11·3	10·8	**7·2**	9·2	11·7	18·2	12·2	11·0	**20·2**	**17·5**	10·0
23	13·9	**5·9**	10·0	10·3	11·0	12·5	14·0	11·0	9·2	18·4	9·4	9·2
24	15·8	6·1	8·5	9·4	11·4	13·7	**8·0**	9·2	9·4	12·7	10·0	12·7
25	15·0	12·1	13·5	9·7	12·1	**21·5**	13·3	9·4	11·7	9·2	8·1	**14·9**
26	**17·6**	14·3	14·8	12·0	12·2	20·1	22·8	9·6	12·8	7·5	9·7	8·1
27	10·4	14·0	12·8	9·6	11·4	20·2	24·2	10·7	11·7	7·5	11·2	10·4
28	9·7	12·7	12·9	8·5	10·5	17·9	22·9	**8·4**	15·2	6·8	10·0	8·2
29	8·0	10·3	12·6	7·8	12·1	14·8	21·0	10·0	16·2	7·7	10·4	8·6
30	9·0		12·1	11·5	10·8	15·4	19·7	10·5	13·8	8·3	9·3	9·7
31	8·3		10·1		9·3		21·1	9·5		9·2		8·8
Monthly Mean.	10·6	12·1	10·2	10·4	10·5	14·7	**19·7**	13·9	13·3	**9·2**	10·1	9·8
Annual Variation ..	—1·4	+0·1	—1·8	—1·6	—1·5	+2·7	+7·7	+1·9	+1·3	—2·8	—1·9	—2·2

	Miles.
The Mean Velocity for June to August	16·1
The Mean Velocity for September to May	10·7
The Mean Velocity for the year	12·0
The greatest monthly mean (that of July)	19·7
The least monthly mean (that of October)	9·2
Difference =	10·5
The greatest mean daily Velocity of Wind in the year (that of 14th July) was	30·8
The least do. do. do. (that of 18th October) was... ...	5·5
Difference =	25·3

Aggregate and Mean Velocities and Relative Frequency of Different Winds, 1880.

TABLE XVI.—*Showing, for the year* 1880, *the sum of the Velocities, and the Mean Velocities, in miles per hour, of the Winds which blew in each Month, from each of the Sixteen Principal Directions; and also the number of Observations which those sums comprise; the latter numbers indicating the Relative Frequency of the same Wind (as to direction) in the several Months, and of different Winds during the same Month.*

1880.	N.			NNE.			NE.			ENE.			E.			ESE.			SE.			SSE.		
MONTH.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	808	101	8·0	477	68	7·0	1440	129	11·2	800	84	9·5	195	24	8·1	80	12	6·7	0	0	...	0	0	...
February ...	1197	119	10·6	412	55	7·5	487	63	7·7	198	21	9·4	69	14	4·9	146	18	8·1	68	9	7·6	41	6	6·8
March ...	301	42	7·2	200	39	5·1	122	22	5·5	80	12	6·7	63	15	4·2	161	22	7·3	189	21	9·0	168	18	9·3
April ...	289	44	6·6	118	21	5·6	94	14	6·7	18	3	6·0	29	5	5·8	91	12	7·6	82	12	6·8	182	20	9·1
May ...	60	11	5·5	36	6	6·0	11	2	5·5	0	0	...	0	0	...	16	3	5·3	0	0	...	17	3	5·7
June ...	19	2	9·5	46	3	15·3	18	2	9·0	42	4	10·5	64	7	9·1	51	6	8·5	150	11	13·6	178	12	14·8
July ...	5	1	5·0	3	1	3·0	0	0	...	0	0	...	33	4	8·2	22	2	11·0	0	0	...	127	8	15·9
August ...	0	0	...	12	2	6·0	0	0	...	23	3	7·7	21	4	5·2	22	3	7·3	0	0	...	26	2	13·0
September ...	66	7	9·4	60	8	7·5	49	8	6·1	0	0	...	30	5	6·0	98	15	6·5	152	14	10·9	389	24	16·2
October ...	511	92	5·6	262	42	6·2	365	54	6·8	325	40	8·1	198	28	7·1	320	40	8·0	416	39	10·7	459	32	14·3
November ...	518	72	7·2	374	49	7·6	1924	188	10·2	1023	96	10·7	223	25	8·9	150	19	7·9	60	7	8·6	9	1	9·0
December ...	777	102	7·6	602	86	7·0	1274	156	8·2	1077	100	10·8	157	22	7·1	95	11	8·6	0	0	...	0	0	...
Year ...	4551	593	7·7	2602	380	6·8	5784	638	9·1	3586	363	9·9	1082	153	7·1	1252	163	7·7	1117	113	9·9	1596	126	12·7

1880.	S.			SSW.			SW.			WSW.			W.			WNW.			NW.			NNW.		
Month.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	0	0	...	4	1	4·0	7	1	7·0	5	1	5·0	95	12	7·9	196	20	9·8	1244	104	12·0	2550	187	13·6
February ...	0	0	...	0	0	...	0	0	...	20	2	10·0	58	7	8·3	449	55	8·2	1357	100	13·6	3911	227	17·2
March ...	300	22	13·6	562	54	10·4	201	24	8·4	588	52	11·3	373	38	9·8	916	97	9·4	1690	128	13·2	1686	132	12·8
April ...	122	12	10·2	140	16	8·7	218	22	9·9	539	58	9·3	882	91	9·7	1806	175	10·3	1599	131	12·2	1301	82	15·9
May ...	0	0	...	96	10	9·6	245	25	9·8	596	56	10·6	1056	117	9·0	3205	293	10·9	2213	193	11·5	257	25	10·3
June ...	108	6	18·0	301	19	15·8	335	24	14·0	3587	230	15·6	4426	303	14·6	1033	72	14·3	128	13	9·8	75	6	12·5
July ...	282	16	17·6	317	15	21·1	191	18	10·6	7305	346	21·1	5548	277	20·0	702	43	16·3	125	11	11·4	20	2	10·0
August ...	31	3	10·3	85	8	10·6	365	34	10·7	3705	243	15·2	4637	304	15·3	1017	101	10·1	396	35	11·3	31	2	15·5
September ...	340	21	16·2	317	24	13·2	284	23	12·3	1518	100	15·2	2152	155	13·9	1737	149	11·7	1762	125	14·1	628	41	15·3
October ...	579	38	15·2	260	23	11·3	159	24	6·6	151	22	6·8	127	16	7·9	414	51	8·1	1149	97	11·8	1139	103	11·1
November ...	13	2	6·5	0	0	...	5	1	5·0	24	3	8·0	66	10	6·6	388	44	8·8	832	78	10·7	1677	125	13·4
December ...	0	0	....	0	0	...	0	0	...	22	4	5·5	126	15	8·4	479	51	9·4	968	83	11·7	1727	114	15·1
Year ...	1775	120	14·8	2082	170	12·2	2010	196	10·3	18060	1117	16·2	19546	1345	14·5	12342	1151	10·7	13463	1098	12·3	15002	1046	14·3

TABLE XVII.—Barometric Pressure, 1881.

Height of Barometer above mean Sea level=87 feet.

1881. Date.	MONTH.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	29·963	29·960	29·850	29·892	29·771	29·703	29·674	29·679	29·764	29·793	29·841	29·914
2	·921	·950	·858	**·900**	·716	·709	·645	·586	·771	·757	·855	·875
3	·970	·971	·879	·851	·682	·693	·608	**·540**	·810	·737	·829	·867
4	·995	·990	·874	·826	**·679**	·700	·660	·580	·791	·733	·803	·880
5	30·012	30·013	·849	·828	·716	·702	·679	·664	·783	**·722**	·855	·931
6	29·970	·036	**·842**	·864	·741	·676	·629	·695	·805	·744	·874	·952
7	·946	**·041**	·892	·862	·763	·666	·677	·708	·803	·782	·814	·942
8	·944	29·977	·877	·799	·784	·669	·691	·713	·783	·809	·807	·935
9	·924	·900	·896	·816	·791	·677	·632	·731	·739	·812	·815	·894
10	·942	·881	·902	·796	·809	**·635**	·623	·685	·700	·831	·795	·871
11	·942	·890	·917	·783	·824	·640	·609	·655	·724	·817	·821	**·860**
12	·906	·933	·886	·803	·781	·675	**·574**	·688	·724	·773	·837	·896
13	**·872**	·934	·868	·862	·791	·711	·641	·701	**·652**	·790	·814	·901
14	·926	·907	·884	·865	·808	·734	·713	·695	·688	·822	**·791**	·885
15	**30·018**	·927	·882	·794	**·829**	·705	·671	·734	·759	·863	·810	·885
16	·008	·963	·881	·808	·805	·702	·644	·730	·788	·859	·825	·927
17	29·958	·951	·881	·820	·773	·723	·619	·696	·812	·844	·841	·962
18	·943	·956	·891	·824	·734	·719	·646	·665	·800	·863	·831	·935
19	·944	·964	·917	·792	·722	·718	·726	·655	·738	·899	·861	·946
20	·940	·942	·936	·814	·755	·755	·738	·672	·710	·909	·889	**·964**
21	·946	·973	·911	·845	·774	**·797**	·751	·702	·747	·891	·909	·944
22	·972	·961	·922	·811	·769	·765	·734	·708	·819	·839	·913	·926
23	·978	·939	·913	·779	·722	·709	·668	·715	**·835**	·852	·939	·921
24	·990	·930	·886	·801	·710	·734	·637	·707	·811	·878	**·963**	·912
25	30·005	·903	·888	·805	·739	·725	·644	·685	·814	·911	·940	·883
26	·003	**·875**	·889	·848	·758	·779	·680	·703	·808	**·921**	·918	·904
27	·005	·911	·938	·793	·741	·673	·723	·757	·830	·873	·936	·933
28	29·987	·898	**·941**	**·729**	·722	·676	·736	**·792**	·808	·846	·942	·907
29	·970		·941	·733	·743	·695	·779	·773	·797	·876	·948	·898
30	·963		·935	·770	·749	·691	**·791**	·781	·786	·872	·928	·933
31	·994		·920		·731		·747	·776		·836		·963
Monthly Mean .	**29·963**	29·946	29·895	29·817	29·756	29·705	**29·677**	29·696	29·773	29·831	29·865	29·914
Annual Variation ...	+·143	+·126	+·075	−·003	−·064	−·115	−·143	−·124	−·047	+·011	+·045	+·094

	in.
The greatest mean daily barometric pressure in the year (that of 7th February) was ...	30·041
The least do. do. do. (that of 3rd August) was ...	29·540
Difference =	·501

TABLE XVIII.—Temperature of the Air, 1881.

1881. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	75·6	**74·6**	79·1	80·4	**83·0**	85·2	79·7	81·3	79·8	79·9	81·1	76·0
2	75·8	75·1	79·0	**80·1**	83·5	85·7	**78·4**	80·3	80·9	79·5	81·5	76·5
3	74·3	75·7	79·0	80·4	84·0	**86·1**	80·2	**77·4**	81·5	79·2	81·6	76·9
4	74·3	76·4	77·3	80·4	83·4	86·0	78·4	79·7	81·2	80·4	79·6	78·3
5	74·0	77·9	**76·2**	80·7	83·8	85·7	78·9	80·8	80·6	80·9	78·0	76·7
6	74·8	78·9	78·1	82·8	84·6	84·7	81·0	**81·5**	80·7	81·2	78·5	76·2
7	77·1	79·1	77·5	84·4	85·3	85·0	**83·3**	79·7	81·2	81·0	78·1	75·7
8	76·3	78·8	77·2	84·5	85·4	81·8	83·1	80·5	79·5	80·1	78·3	74·5
9	74·9	78·2	80·1	82·8	85·4	**77·5**	81·4	80·7	78·8	79·6	80·0	75·0
10	**73·5**	76·3	**80·9**	81·6	85·1	79·1	79·8	79·1	80·6	79·6	80·7	74·3
11	74·1	76·0	80·6	81·2	84·9	79·0	79·7	79·3	80·5	80·1	80·3	75·3
12	75·3	75·8	80·7	80·7	84·9	83·3	80·7	79·6	**76·6**	79·5	80·6	76·3
13	76·7	75·3	80·6	81·6	85·5	84·1	81·5	79·4	77·5	79·8	79·3	77·1
14	77·8	75·2	79·3	81·8	85·1	83·1	81·6	80·2	81·2	81·5	82·2	77·6
15	78·0	76·6	77·7	81·5	85·2	84·4	80·9	80·6	80·9	82·3	**82·7**	79·2
16	77·4	77·7	77·6	81·7	85·1	84·6	81·1	80·6	80·5	81·2	81·9	**79·9**
17	76·1	77·5	78·9	82·0	85·2	83·9	80·9	79·7	81·3	79·7	81·2	78·4
18	76·2	77·5	78·4	81·9	85·3	84·1	81·4	80·0	81·1	**79·1**	79·0	77·8
19	77·6	77·7	78·3	81·6	85·6	84·6	81·9	80·8	81·1	79·7	75·4	76·7
20	77·5	77·7	78·9	82·7	85·4	84·4	82·1	80·7	81·2	79·9	75·0	75·7
21	**78·2**	77·8	80·7	82·9	85·4	84·7	81·7	81·2	**81·7**	80·4	77·8	75·5
22	77·8	77·0	80·1	81·9	85·7	84·5	80·9	80·7	79·7	81·1	76·9	75·1
23	77·7	77·2	79·2	82·5	85·6	82·0	80·4	79·0	80·6	**82·4**	75·7	75·6
24	76·8	77·7	79·0	82·1	85·6	79·7	80·6	79·7	79·9	81·6	75·3	74·6
25	77·7	79·0	79·0	82·7	85·9	81·8	80·8	80·9	80·7	81·4	74·9	**73·6**
26	77·3	**80·9**	79·1	82·6	86·0	81·1	80·8	81·3	80·2	80·3	**74·7**	73·8
27	76·7	80·5	79·3	83·9	85·3	81·4	80·7	80·9	78·2	80·2	75·7	74·5
28	76·5	79·3	79·6	**85·1**	**86·5**	83·2	81·5	81·0	79·9	80·1	76·1	74·9
29	75·2		80·0	84·0	86·0	82·7	80·4	80·7	80·8	80·9	77·1	74·6
30	74·8		80·4	83·5	85·0	82·6	81·1	80·8	81·1	79·8	77·3	76·9
31	74·3		80·7		85·8		80·9	80·7		80·4		79·2
Monthly Mean...	**76·1**	77·4	79·1	82·2	**85·1**	83·2	80·8	80·3	80·3	80·4	78·6	76·2
Annual Variation ...	−3·9	−2·6	−0·9	+2·2	+5·1	+3·2	+0·8	+0·3	+0·3	+0·4	−1·4	−3·8

	°
The greatest mean daily temperature of the air in the year (that of 28th May) was ...	86·5
The least do. do. do. (that of 10th January) was	73·5
Difference =	13·0

Table XIX.—Pressure of Vapour, 1881.

1881. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·641	0·591	**0·822**	0·770	0·865	0·935	0·888	0·875	0·849	0·904	0·692	0·628
2	·639	·630	·805	·765	·844	·926	·883	·883	·860	·891	·645	·622
3	·607	·607	·752	·780	**·842**	·904	·909	·872	·859	·897	·572	·613
4	·555	·579	·634	·754	·923	·901	·881	·893	·840	·905	·676	**·539**
5	·548	·566	**·576**	·771	·955	·907	·897	·892	·845	**·929**	·718	·569
6	·586	·629	·635	·814	**·959**	·889	·926	**·906**	·833	·929	·661	·556
7	·646	·620	·641	·794	·944	·901	·940	·873	·831	·886	·685	·564
8	**·671**	·586	·683	·790	·917	·860	**·941**	·880	·810	·864	·735	·590
9	·559	·587	·674	·753	·923	**·809**	·929	·874	·826	·874	·789	·579
10	**·445**	·642	·676	**·714**	·915	·880	·911	·855	·831	·883	·819	·597
11	·528	·573	·702	·775	·899	·911	·894	·861	·839	·893	·863	·577
12	·587	**·486**	·757	·787	·912	·904	·896	·859	·820	·840	·831	·603
13	·606	·573	·713	·811	·924	·902	·893	·857	·841	·831	·578	·648
14	·642	·665	·733	·812	·938	·905	·906	·862	·881	·843	·687	·655
15	·652	·728	·693	·838	·913	·890	·888	·868	·877	·862	·834	·642
16	·604	·752	·734	·836	·899	·906	·884	·876	**·893**	·831	**·882**	·618
17	·555	·726	·759	·810	·892	·905	·880	·854	·887	·802	·866	·595
18	·518	·713	·680	·864	·891	·914	·894	·865	·861	·830	·662	·587
19	·562	·703	·667	·877	·889	·917	·898	·852	·867	·820	·421	·581
20	·599	·706	·693	·867	·891	·918	·890	·874	·865	·815	**·417**	·594
21	·655	·696	·716	·845	·887	·912	·874	·896	·855	·823	·459	·599
22	·632	·680	·771	·852	·890	·893	·876	·861	·846	·785	·520	·621
23	·573	·720	·726	·855	·894	·864	·879	·869	·803	·777	·543	·629
24	·548	·724	·698	·847	·881	·876	·884	·875	**·791**	·777	·544	·617
25	·580	·766	·693	·874	·893	·910	·887	·877	·806	·747	·546	·645
26	·587	·817	·592	·903	·878	·893	·885	·860	·839	·752	·564	·635
27	·547	**·845**	·696	·916	·845	·929	·883	·869	·856	·755	·589	**·674**
28	·495	·800	·703	·912	·919	**·936**	·896	·864	·878	·768	·614	·661
29	·468		·728	**·937**	·919	·934	·881	**·846**	·883	**·721**	·610	·664
30	·531		·754	·868	·941	·925	·872	·867	·893	·727	·595	·672
31	·572		·794		·937		**·862**	·853		·727		·611
Monthly Mean...	**0·579**	0·668	0·706	0·826	**0·904**	0·902	0·894	0·870	0·849	0·829	0·654	0·612
Annual Variation ...	−0·195	−0·106	−0·068	+0·052	+0·130	+0·128	+0·120	+0·096	+0·075	+0·055	−0·120	−0·162

	in.
The greatest mean daily pressure of vapour in the year (that of 6th May) was ...	0·959
The least do. do. do. (that of 20th November) was...	0·417
Difference =	0·542

TABLE XX.—Additional Capacity of the Air, 1881.

1881. Date.	MONTH.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·258	0·271	0·176	0·269	0·266	0·281	0·128	0·192	0·169	0·116	0·380	0·271
2	·255	·245	·189	·266	·306	·308	·088	·151	·195	·117	·442	·299
3	·244	·288	·244	·260	·330	·345	·125	·068	·215	·101	·517	·325
4	·298	·337	·303	·287	·225	·346	·090	·119	·225	·137	·345	·439
5	·298	·398	·332	·282	·213	·327	·091	·161	·201	·126	·243	·358
6	·283	·370	·333	·311	·233	·305	·133	·168	·215	·137	·316	·351
7	·295	·385	·305	·390	·273	·303	·198	·140	·235	·174	·281	·331
8	·239	·408	·256	·401	·299	·228	·193	·162	·197	·166	·236	·272
9	·309	·386	·357	·369	·297	·136	·141	·174	·162	·138	·239	·297
10	·384	·269	·386	·368	·295	·116	·106	·141	·212	·131	·235	·259
11	·321	·331	·345	·291	·303	·060	·119	·142	·203	·135	·173	·307
12	·299	·411	·294	·262	·290	·239	·151	·152	·094	·169	·216	·311
13	·317	·308	·333	·272	·303	·269	·181	·149	·101	·190	·426	·289
14	·318	·212	·271	·275	·273	·228	·174	·170	·184	·237	·420	·298
15	·311	·191	·258	·240	·302	·291	·168	·175	·177	·248	·288	·365
16	·343	·199	·218	·249	·313	·282	·177	·169	·149	·238	·208	·409
17	·353	·220	·230	·287	·324	·256	·173	·160	·181	·216	·201	·379
18	·395	·234	·293	·229	·326	·255	·177	·160	·201	·166	·333	·372
19	·396	·249	·304	·204	·341	·270	·193	·175	·194	·199	·465	·346
20	·353	·246	·303	·256	·333	·262	·217	·172	·202	·208	·463	·300
21	·315	·261	·339	·284	·335	·281	·207	·168	·225	·222	·502	·295
22	·325	·250	·260	·239	·344	·293	·179	·186	·168	·283	·411	·259
23	·379	·221	·273	·258	·337	·229	·160	·123	·243	·340	·353	·265
24	·379	·229	·294	·254	·348	·141	·162	·146	·231	·308	·341	·243
25	·373	·229	·298	·247	·348	·176	·163	·178	·245	·329	·330	·188
26	·354	·241	·405	·212	·367	·171	·166	·210	·191	·286	·305	·202
27	·377	·198	·308	·248	·371	·144	·167	·184	·109	·284	·304	·182
28	·423	·202	·311	·301	·348	·200	·179	·195	·144	·267	·294	·207
29	·412		·299	·232	·327	·182	·157	·202	·168	·339	·331	·196
30	·337		·286	·283	·265	·191	·190	·185	·168	·295	·355	·260
31	·282		·255		·303		·192	·194		·317		·395
Monthly Mean.	0·330	0·278	0·292	0·278	0·308	0·238	0·159	0·164	0·187	0·214	0·332	0·299
Annual Variation	+0·073	+0·021	+0·035	+0·021	+0·051	−0·019	−0·098	−0·093	−0·070	−0·043	+0·075	+0·042

	in.
The greatest mean daily additional capacity of the air in the year (that of 3rd November) was	0·517
The least do. do. do. (that of 3rd August) was ...	0·068
Difference =	0·449

Rainfall, 1881.

TABLE XXI.—*Total Fall of Rain (in inches) as measured by F. Chambers's Self-registering Gauge, the funnel of which is 28 feet above the ground.*

1881. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
			in.		in.	in.	in.	in.	in.	in.	in.	
1						0·12	2·44	0·02	0·35	0·26		
2							2·84	0·65	0·08	1·60		
3							1·33	**11·09**	0·01	2·14		
4							3·65	1·32	0·31	0·06		
5							2·74	0·18	0·24			
6						0·33	2·90		0·25			
7							0·03	0·58	0·01			
8						0·31	0·01	0·26				
9						1·51	1·51	0·02	0·07			
10						**3·09**	**4·56**	0·56				
11						2·36	1·95	0·34	0·08			
12						0·15	0·80	0·47	0·55			
13						0·05	0·19	0·18	**0·87**			
14						0·06	0·16	0·04	0·07			
15							0·12	0·02	0·04			
16							0·06	0·14	0·17			
17						0·13	0·23	0·59	0·09			
18						0·04	0·07	0·26			0·04	
19							0·01	0·04	0·13			
20						0·01	0·01	0·14	0·04			
21								0·04	0·03			
22							0·90	0·15	0·11			
23						0·91	0·09	0·56				
24						1·38	0·07	0·38				
25			0·02			0·48	0·18	0·08				
26						0·64	0·44					
27						1·71	0·06		0·82			
28							0·07	0·02				
29						0·40	0·59	0·09	0·05			
30					0·20	0·39	0·12	0·30				
31					0·12		0·12	0·11				
Monthly Total.			0·02		0·32	14·07	**28·25**	18·63	4·37	4·06	0·04	
Number of rainy days ...			1		2	19	**30**	28	21	4	1	

Total fall of rain in the year ... ... 69·76 inches.

Total number of rainy days in the year 106

The greatest daily fall of rain in the year (that of 3rd August) was ... ... 11·09 inches.

No rain fell in the months of January, February, April and December, nor on any of the days left blank in the above table.

The entries, for June 10 and 11 bracketed together, are correct in the aggregate, but only approximate in the distribution.

Mean daily velocities of the North and East Components of the Wind, 1881.

TABLE XXII.—*Showing the mean velocities of the North or South and East or West components of the winds which blew on each day of the year* 1881.

In Miles per Hour.

1881.	MONTH.																					
Date.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
1	7·6 N	1·9 W	7·9 N	2·7 W	7·9 N	5·4 W	3·3 N	5·8 W	4·5 N	5·9 W	3·7 S	11·4 W	1·3 N	16·4 W	6·3 S	25·0 W	3·8 S	17·4 W	2·2 N	2·5 W	9·1 N	2·7 E	5·7 N	0·8 E
2	6·3 N	0·1 W	5·4 N	0·8 W	2·8 N	4·0 W	6·8 N	5·1 W	4·5 N	5·7 W	1·7 N	14·6 W	4·5 S	4·1 W	2·2 S	21·9 W	7·0 S	19·0 W	3·3 N	4·1 W	9·2 N	5·2 E	5·6 N	3·4 E
3	7·5 N	0·1 W	9·1 N	1·8 W	5·3 N	6·1 W	14·1 N	10·3 W	9·7 N	6·3 W	0·0	16·0 W	4·6 S	2·5 W	2·5 N	18·8 W	3·7 S	17·7 W	7·3 N	4·0 W	9·6 N	6·9 E	6·5 N	3·7 E
4	10·6 N	0·1 W	8·6 N	0·0	11·1 N	7·5 W	13·9 N	11·2 W	4·5 N	4·6 W	3·1 N	15·0 W	5·7 S	5·4 W	5·1 S	25·5 W	1·0 S	15·1 W	6·4 N	0·1 E	5·5 N	4·0 E	6·8 N	9·0 E
5	13·1 N	2·9 W	7·3 N	0·4 E	8·3 N	0·2 W	11·6 N	8·5 W	4·6 S	5·2 W	3·5 N	14·8 W	7·2 S	6·6 W	7·8 S	15·3 W	2·8 S	11·0 W	4·6 N	0·7 W	0·5 S	7·2 E	5·3 N	2·7 E
6	11·0 N	1·8 W	3·9 N	1·4 E	1·2 S	3·9 W	10·0 N	5·6 W	9·5 S	3·9 W	11·1 N	16·1 W	2·6 S	18·3 W	6·3 S	15·3 W	0·8 S	6·8 W	3·3 S	3·1 W	0·0	18·7 E	4·7 N	2·2 E
7	5·3 N	0·1 E	6·1 N	1·9 E	4·7 N	5·2 W	8·3 N	4·3 W	20·5 S	4·0 W	10·6 N	12·9 W	8·3 S	20·0 W	3·4 S	16·5 W	1·4 S	7·3 W	4·9 N	2·9 W	2·2 N	8·8 E	4·9 N	2·9 E
8	6·9 N	1·7 W	3·7 N	0·7 W	8·7 N	3·5 W	12·9 N	7·8 W	18·3 S	6·2 W	9·3 N	6·8 W	8·4 S	14·6 W	6·6 S	18·1 W	0·8 S	11·0 W	7·9 N	4·0 W	2·4 N	5·0 E	4·0 N	2·2 E
9	12·0 N	2·4 W	4·5 N	0·9 E	13·5 N	5·7 W	16·7 N	8·8 W	9·9 S	8·0 W	3·3 S	3·7 W	8·0 S	19·0 W	7·6 S	19·8 W	2·2 S	0·9 W	10·6 N	6·1 W	6·4 N	2·9 E	5·6 N	2·4 E
10	13·8 N	3·2 W	5·6 N	1·8 W	12·1 N	7·1 W	7·4 N	2·6 W	3·9 S	7·0 W	1·6 S	4·5 W	12·5 S	23·6 W	4·1 S	19·3 W	0·9 S	3·6 W	8·3 N	4·1 W	0·1 S	0·0	7·0 N	1·2 E
11	10·1 N	2·7 W	7·3 N	2·3 W	16·7 N	5·0 W	5·5 N	5·9 W	8·5 S	7·5 W	8·6 S	0·3 W	5·9 S	30·3 W	4·3 S	16·8 W	1·7 N	2·7 W	8·2 N	6·3 W	0·9 S	0·1 W	4·2 N	3·4 E
12	6·7 N	0·6 E	11·3 N	3·1 W	15·1 N	7·3 W	6·5 N	6·2 W	5·3 S	4·1 W	0·6 N	10·1 W	11·0 S	27·5 W	5·3 S	16·8 W	2·3 N	2·8 W	6·0 N	4·5 W	7·2 N	1·9 W	5·5 N	3·0 E
13	3·6 N	2·5 E	8·2 N	3·3 W	13·7 N	5·8 W	7·1 N	5·3 W	2·0 S	5·1 W	1·3 N	10·5 W	17·0 S	17·0 W	0·4 S	17·6 W	1·4 S	8·9 W	9·2 N	2·9 W	9·4 N	1·6 E	3·8 N	1·8 E
14	1·7 N	3·4 E	3·8 N	2·1 W	11·5 N	6·0 W	12·8 N	7·8 W	2·4 N	5·9 W	3·8 S	16·9 W	8·6 S	19·7 W	1·3 S	15·3 W	7·7 S	10·9 W	6·2 N	1·0 W	6·8 N	6·1 E	7·4 N	1·0 E
15	3·8 N	1·1 E	0·6 S	1·0 W	8·1 N	5·8 W	9·7 N	7·0 W	3·3 S	7·3 W	1·1 S	19·2 W	9·1 S	22·1 W	3·7 S	14·3 W	13·4 S	7·3 W	5·2 N	0·6 W	1·1 S	0·5 W	8·1 N	4·5 E
16	7·1 N	0·2 E	4·2 N	3·3 W	6·2 N	2·9 W	6·8 N	6·0 W	2·3 S	6·3 W	6·8 S	15·4 W	9·3 S	18·9 W	0·9 S	17·5 W	7·2 S	7·3 W	7·2 N	1·2 W	1·9 S	2·3 W	9·2 N	5·2 E
17	5·9 N	0·1 W	9·3 N	4·6 W	4·0 N	4·7 W	6·4 N	6·0 W	3·5 S	7·1 W	9·5 S	13·2 W	5·2 S	23·3 W	0·4 N	20·6 W	4·2 S	10·2 W	8·7 N	2·1 W	0·7 S	2·9 W	8·1 N	2·7 E
18	8·1 N	3·0 E	5·6 N	4·3 W	2·9 N	4·6 W	0·3 N	5·3 W	0·1 S	7·2 W	10·0 S	11·9 W	9·1 S	19·9 W	1·9 S	20·6 W	3·5 S	13·8 W	8·4 N	2·2 W	9·0 N	5·9 W	8·3 N	1·6 E
19	8·0 N	4·8 E	8·7 N	3·7 W	5·8 N	5·4 W	6·2 N	6·8 W	0·8 S	7·0 W	13·0 S	10·8 W	11·1 S	14·4 W	5·0 S	19·8 W	5·4 S	18·2 W	4·7 N	1·1 W	1·4 N	0·4 E	7·0 N	0·5 E
20	6·2 N	0·7 E	4·9 N	2·6 W	9·0 N	3·0 W	5·2 N	7·8 W	1·1 N	6·9 W	9·9 S	9·8 W	9·2 S	15·9 W	3·3 S	19·1 W	4·4 S	13·6 W	6·0 N	0·5 E	9·5 N	3·6 E	7·5 N	1·3 E
21	3·8 N	0·2 W	4·4 N	2·7 W	6·1 N	3·8 W	2·3 N	8·0 W	5·9 N	9·2 W	5·9 S	8·9 W	6·9 S	17·1 W	3·3 S	12·0 W	1·3 S	8·4 W	3·2 N	1·1 E	10·2 N	9·5 E	6·1 N	0·9 E
22	5·0 N	0·4 E	7·8 N	2·4 W	5·9 N	6·9 W	5·0 N	7·7 W	7·6 N	10·8 W	6·4 S	6·9 W	8·0 S	19·9 W	2·2 S	12·8 W	8·6 S	1·9 E	4·3 N	1·2 E	9·6 N	5·8 E	4·5 N	2·2 E
23	9·9 N	1·0 W	6·9 N	3·5 W	6·3 N	6·2 W	5·4 N	7·9 W	11·1 N	11·5 W	5·9 S	5·1 W	9·9 S	23·4 W	1·5 S	9·8 W	2·4 S	6·0 W	4·5 N	2·0 E	6·9 N	3·3 E	1·9 N	2·0 E
24	8·9 N	1·7 W	10·5 N	5·0 W	1·6 N	6·8 W	4·7 N	7·9 W	9·7 N	10·3 W	10·2 S	1·3 E	2·1 S	23·6 W	0·3 S	9·6 W	3·9 S	0·2 W	6·7 N	1·1 W	6·1 N	3·4 E	6·5 N	1·1 E
25	1·4 N	0·7 E	11·4 N	1·0 W	1·0 N	5·2 W	7·8 N	8·6 W	4·6 N	10·4 W	5·6 S	7·8 W	6·4 S	22·3 W	0·2 S	10·0 W	3·2 S	4·2 W	7·2 N	0·1 W	1·4 N	4·5 E	4·5 N	0·6 W
26	3·2 N	0·7 E	0·5 S	1·0 W	0·7 N	7·3 W	2·6 N	5·8 W	1·6 N	9·0 W	8·1 S	7·3 W	7·9 S	14·4 W	1·0 S	5·0 W	5·2 N	3·6 W	2·6 N	0·4 E	3·2 N	2·7 E	1·2 N	0·2 W
27	6·4 N	1·1 W	8·5 S	2·5 W	1·4 S	2·5 W	8·8 N	7·7 W	1·3 S	5·1 W	6·1 S	0·6 W	6·2 S	13·0 W	0·5 S	2·0 W	4·3 N	2·9 W	2·7 N	1·7 E	4·1 N	2·3 E	1·8 N	1·0 W
28	7·7 N	0·3 W	2·8 N	3·3 W	0·7 S	3·3 W	6·3 N	6·2 W	16·7 S	0·5 E	5·2 S	4·1 W	8·1 S	13·7 W	1·5 S	4·1 W	5·8 N	3·9 W	6·0 N	1·5 E	5·9 N	3·4 E	3·8 N	1·0 E
29	5·7 N	0·2 W			3·1 S	1·8 W	4·2 S	6·2 W	24·9 S	1·7 E	3·3 S	7·3 W	7·8 S	16·0 W	1·4 S	6·6 W	6·6 N	4·1 W	7·7 N	1·1 E	5·1 N	4·3 E	8·7 N	2·0 W
30	6·0 N	0·7 W			1·2 S	3·7 W	1·7 N	5·3 W	25·3 S	2·7 E	1·5 N	7·4 W	5·8 S	21·4 W	6·6 S	4·3 W	6·7 N	2·5 W	5·7 N	0·9 E	4·9 N	3·9 E	9·3 N	0·5 W
31	6·9 N	1·5 W			0·8 N	3·7 W			14·9 S	8·2 W			2·7 S	22·0 W	3·3 S	11·7 W			7·5 N	0·3 W			9·1 N	6·0 E
Monthly Mean ...	7·1 N	0·2 W	5·7 N	2·0 W	5·9 N	4·9 W	7·1 N	6·8 W	3·5 S	6·2 W	2·6 S	9·6 W	7·4 S	17·6 W	3·1 S	14·9 W	2·0 S	8·0 W	5·8 N	1·4 W	5·0 N	3·4 E	5·9 N	2·1 E
Annual Variation...	5·1 N	5·3 E	3·7 N	3·5 E	3·9 N	0·6 E	5·1 N	1·3 W	5·5 S	0·7 W	4·6 S	4·1 W	9·4 S	12·1 W	5·1 S	9·4 W	4·0 S	2·5 W	3·8 N	4·1 E	3·0 N	8·9 E	3·9 N	7·6 E

The velocities of the mean components for the year are 2·0 N. and 5·5 W.

Velocity of Wind, 1881.

TABLE XXIII.—*Mean Velocity of the Wind, in miles per hour, without regard to the direction from which it blew, for each Day of Bombay Civil Time: also the Mean Monthly Velocity, and its Variation from the Mean of the Year.*

1881. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
1	9·0	9·7	10·8	7·7	8·4	12·3	17·2	26·2	18·6	7·3	13·6	8·1
2	9·2	8·4	7·2	12·4	9·9	14·9	14·9	22·6	**20·4**	7·1	13·4	10·4
3	9·4	10·8	8·5	18·3	13·6	16·0	**9·0**	20·0	18·5	9·2	13·6	11·0
4	12·8	11·2	13·9	18·1	7·6	15·6	13·8	**26·5**	15·3	8·7	10·6	14·1
5	13·8	9·8	12·9	15·5	10·4	15·5	13·9	17·6	11·8	8·2	9·8	10·3
6	11·8	9·2	10·8	12·3	12·9	**20·0**	19·0	16·5	7·7	10·4	**18·8**	10·5
7	7·9	9·9	9·2	11·5	22·7	17·4	21·7	17·3	7·6	9·4	11·6	11·7
8	10·0	6·9	11·5	15·7	20·6	14·8	17·2	19·5	14·0	11·5	9·2	9·0
9	13·5	8·6	15·5	**19·4**	14·1	13·4	21·5	21·3	7·2	**12·7**	10·7	10·5
10	**14·5**	9·6	15·1	10·8	10·0	12·9	27·7	20·3	7·7	10·5	**5·8**	10·0
11	11·7	10·0	**18·4**	8·8	13·0	12·2	**31·6**	17·9	**6·4**	11·0	7·2	11·2
12	9·2	13·0	17·3	10·3	10·8	11·0	30·0	17·8	7·6	9·0	9·9	10·1
13	7·5	11·6	15·5	11·0	7·8	10·7	24·0	17·8	11·2	11·0	12·2	8·0
14	9·2	7·6	13·9	16·8	9·5	17·7	21·6	15·6	14·0	7·5	13·6	10·7
15	8·9	**6·7**	10·9	12·5	9·1	19·4	23·9	15·1	15·8	7·7	6·8	11·6
16	9·2	9·0	9·9	10·4	7·6	17·6	21·3	17·7	10·5	8·7	6·5	13·8
17	7·7	11·3	8·2	11·5	8·4	16·6	24·5	20·7	11·4	10·9	6·4	13·2
18	11·8	9·1	7·3	9·5	7·3	15·8	22·2	21·0	14·5	9·9	11·1	11·2
19	13·5	11·3	10·0	11·0	7·3	17·2	18·5	20·8	19·5	6·4	13·7	8·5
20	9·3	9·0	12·1	11·1	7·3	14·5	18·7	19·9	14·5	9·2	13·5	10·7
21	7·0	7·5	9·2	9·4	11·3	10·9	18·6	12·8	8·7	**5·7**	16·4	9·1
22	8·7	10·7	9·9	10·1	13·7	9·5	21·5	13·5	10·9	7·0	15·0	8·4
23	11·7	9·9	9·6	11·2	16·6	11·7	25·6	11·9	7·2	8·1	11·5	**6·2**
24	10·2	13·0	7·3	10·0	14·4	14·2	24·0	10·7	8·7	8·2	11·7	9·9
25	**6·8**	**13·5**	9·0	12·8	11·7	12·2	23·6	10·4	8·2	9·6	9·5	8·9
26	9·6	9·2	7·7	**6·9**	9·6	13·2	16·8	7·0	8·6	8·4	8·0	7·0
27	9·9	12·3	9·1	12·5	**5·9**	9·5	14·7	**6·2**	7·9	6·7	8·0	6·5
28	11·6	8·2	7·2	10·6	18·5	**7·7**	16·2	6·5	9·2	10·2	10·5	8·5
29	8·0		7·3	10·7	26·7	10·6	18·1	7·7	8·4	10·4	11·3	10·9
30	8·3		6·5	8·3	**27·2**	11·3	22·5	9·9	8·9	10·0	10·0	11·5
31	8·8		**6·4**		17·6		22·6	12·7		9·8		**14·2**
Monthly Mean.	10·0	9·9	10·6	11·9	12·6	13·9	**20·5**	16·2	11·4	**9·0**	11·0	10·2
Annual Variation ...	−2·3	−2·4	−1·7	−0·4	+0·3	+1·6	+8·2	+3·9	−0·9	−3·3	−1·3	−2·1

	Miles.
The Mean Velocity for June to August	16·9
The Mean Velocity for September to May	10·7
The Mean Velocity for the Year	12·3
The greatest monthly mean (that of July)	20·5
The least monthly mean (that of October)	9·0
Difference =	11·5
The greatest mean daily Velocity of Wind in the year (that of 11th July) was	31·6
The least do. do. do. (that of 21st October) was	5·7
Difference =	25·9

Aggregate and Mean Velocities and Relative Frequency of Different Winds, 1881.

TABLE XXIV.—*Showing, for the year* 1881, *the sum of the Velocities, and the Mean Velocities, in miles per hour, of the Winds which blew in each Month, from each of the sixteen Principal Directions; and also the number of Observations which those sums comprise; the latter numbers indicating the Relative Frequency of the same Wind (as to direction) in the several Months, and of different Winds during the same Month.*

1881.	N.			NNE.			NE.			ENE.			E.			ESE.			SE.			SSE.		
MONTH.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	930	109	8·5	534	78	6·8	1067	133	8·0	828	95	8·7	225	34	6·6	68	6	11·3	0	0	...	0	0	...
February ...	389	56	6·9	643	93	6·9	681	93	7·3	348	45	7·7	202	31	6·5	99	14	7·1	29	4	7·2	109	9	12·1
March ...	297	42	7·1	237	34	7·0	191	23	8·3	217	22	9·9	24	4	6·0	269	31	8·7	108	14	7·7	27	4	6·7
April ...	291	39	7·5	269	43	6·3	142	19	7·5	62	10	6·2	53	11	4·8	84	13	6·5	16	3	5·3	6	1	6·0
May ...	57	9	6·3	65	12	5·4	4	1	4·0	0	0	...	11	1	11·0	36	5	7·2	197	14	14·1	753	38	19·8
June ...	54	7	7·7	35	5	7·0	43	4	10·7	39	3	13·0	19	2	9·5	186	14	13·3	219	16	13·7	367	28	13·1
July ...	6	1	6·0	5	1	5·0	0	0	...	16	2	8·0	0	0	...	12	1	12·0	133	10	13·3	243	16	15·2
August ...	0	0	...	4	1	4·0	9	2	4·5	0	0	...	5	1	5·0	36	4	9·0	67	8	8·4	71	7	10·1
September ...	91	17	5·4	129	22	5·9	31	5	6·2	19	5	3·8	24	4	6·0	180	19	9·5	181	18	10·1	123	14	8·8
October ...	469	76	6·2	408	76	5·4	628	85	7·4	552	76	7·3	148	21	7·0	221	39	5·7	0	0	...	41	5	8·2
November ...	412	58	7·1	231	28	8·2	881	74	11·9	2064	161	12·8	918	67	13·7	513	56	9·2	120	16	7·5	37	7	5·3
December ...	664	91	7·3	234	35	6·7	902	91	9·9	1863	165	11·3	442	54	8·2	414	52	8·0	7	1	7·0	0	0	...
Year ...	3660	505	7·2	2794	428	6·5	4579	530	8·6	6008	584	10·3	2071	230	9·0	2118	254	8·3	1077	104	10·4	1777	129	13·8

1881.	S.			SSW.			SW.			WSW.			W.			WNW.			NW.			NNW.		
Month.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	7	1	7·0	0	0	...	0	0	...	8	1	8·0	256	32	8·0	402	43	9·3	1025	83	12·3	2097	128	16·4
February ...	47	2	23·5	73	5	14·6	69	9	7·7	41	4	10·2	253	32	7·9	798	70	11·4	1755	124	14·2	1109	81	13·7
March ...	19	3	6·3	26	6	4·3	45	10	4·5	246	34	7·2	651	74	8·8	1000	107	9·3	2528	207	12·2	1991	127	15·7
April ...	95	7	13·6	70	10	7·0	48	6	8·0	116	11	10·5	353	36	9·8	1799	147	12·2	3551	241	14·7	1624	122	13·3
May ...	1422	60	23·7	1316	74	17·8	823	69	11·9	879	98	9·0	811	99	8·2	1581	141	11·2	1123	96	11·7	316	26	12·2
June ...	199	13	15·3	468	36	13·0	1870	149	12·6	1636	126	13·0	2565	177	14·5	1630	107	15·2	463	22	21·0	198	10	19·8
July ...	59	5	11·8	97	7	13·9	2345	125	18·8	9118	422	21·6	2951	129	22·9	244	19	12·8	41	5	8·2	8	1	8·0
August ...	65	6	10·8	71	9	7·9	293	25	11·7	5241	300	17·5	5748	338	17·0	350	38	9·2	56	3	18·7	20	1	20·0
September ...	214	20	10·7	435	35	12·4	545	51	10·7	2859	205	13·9	2163	183	11·8	442	54	8·2	464	37	12·5	285	31	9·2
October ...	85	6	14·2	17	2	8·5	22	4	5·5	43	6	7·2	75	8	9·4	346	37	9·4	2078	162	12·8	1600	141	11·3
November ...	0	0	...	0	0	...	6	1	6·0	92	14	6·6	229	31	7·4	286	42	6·8	780	67	11·6	1357	97	14·0
December ...	0	0	...	0	0	...	9	2	4·5	4	1	4·0	45	6	7·5	410	45	9·1	961	88	10·9	1603	113	14·2
Year ...	2212	123	18·0	2573	184	14·0	6075	451	13·5	20283	1222	16·6	16100	1145	14·1	9288	850	10·9	14825	1135	13·1	12208	878	13·9

TABLE XXV.—Barometric Pressure, 1882.

Height of Barometer above mean Sea-level = 37 feet.

1882.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	29·948	**29·984**	**29·974**	29·792	29·805	29·657	29·727	**29·608**	29·755	**29·736**	29·784	**29·824**
2	**·914**	·973	·966	·810	·763	·556	·682	·649	·769	·745	·824	·873
3	·921	·918	·932	**·824**	·768	·545	·634	·690	·761	·762	·861	·887
4	·932	·907	·882	·780	·785	·568	·570	·696	·725	·803	·851	·923
5	·941	·919	·940	·778	·816	·582	·546	·664	·705	·840	·835	·937
6	·936	·940	·944	·794	·816	·573	**·519**	·642	·680	·833	·852	·921
7	·979	·921	·916	·807	·834	·548	·532	·660	·684	·836	·863	·889
8	30·000	·908	·871	·809	·858	·536	·621	·719	·708	·849	·843	·895
9	29·973	·916	·887	·813	**·868**	·535	·671	·718	·670	·852	·838	·916
10	·928	·879	·876	·824	·825	·495	·673	·689	·632	·811	·851	·896
11	·974	**·847**	·884	·802	·813	·443	·653	·698	**·610**	·755	·891	·901
12	30·022	·864	·909	·780	·817	**·433**	·622	·725	·708	·747	·910	·917
13	·007	·902	·948	·782	·778	·529	·615	·753	·837	·766	·900	·929
14	·011	·883	·931	·762	·759	·595	·616	·765	**·858**	·758	·912	·899
15	·020	·890	·907	·760	·784	·646	·647	·731	·819	·752	·942	·893
16	·006	·918	·913	**·708**	·807	·682	·631	·742	·812	·759	·932	·938
17	29·969	·924	·885	·741	·769	·704	·585	·773	·810	·816	·940	·973
18	·990	·924	·868	·726	·696	·725	·585	·775	·814	·833	·935	·998
19	30·051	·960	·877	·758	·704	·756	·590	·771	·812	·806	·933	**30·004**
20	**·058**	·960	·844	·754	·711	**·786**	·595	·795	·837	·804	**·943**	·003
21	·001	·878	·806	·753	·724	·771	·588	**·804**	·844	·810	·923	29·971
22	29·954	·892	·832	·744	·726	·738	·581	·776	·846	·797	·890	·957
23	·949	·950	·831	·734	·724	·748	·631	·744	·831	·791	·850	·941
24	·946	·953	·768	·768	·744	·745	·694	·758	·825	·817	·838	·958
25	·921	·924	**·766**	·746	·764	·744	·717	·776	·818	·833	·787	·956
26	·921	·916	·836	·778	·740	·772	**·747**	·758	·806	**·855**	**·769**	·965
27	·917	·898	·851	·799	·742	·775	·722	·758	·812	·845	·774	·961
28	·936	·923	·824	·786	·729	·756	·678	·781	·817	·817	·856	·969
29	·936		·821	·791	·725	·765	·652	·800	·787	·806	·893	·964
30	·922		·812	·792	**·673**	·742	·651	·766	·734	·788	·848	·971
31	·946		·771		·685		·636	·737		·770		·975
Monthly Mean	**29·965**	29·917	29·873	29·776	29·766	29·648	**29·633**	29·733	29·771	29·800	29·869	29·936
Annual Variation.	+·158	+·110	+·066	—·031	—·041	—·159	—·174	—·074	—·036	—·007	+·062	+·129

	in.
The greatest mean daily barometric pressure in the year (that of 20th January) was	30·058
The least do. do. do. (that of 12th June) was	29·433
Difference =	0·625

TABLE XXVI.—Temperature of the Air, 1882.

1882. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.
	°	°	°	°	°	°	°	°	°	°	°	°
1	**79·4**	74·5	74·2	83·3	84·0	**84·7**	77·9	78·9	79·7	82·2	76·9	77·6
2	77·8	74·1	74·7	82·7	83·1	78·1	77·9	79·4	78·4	80·3	76·8	77·5
3	77·0	72·7	73·0	83·0	**82·0**	**77·6**	78·0	80·4	**76·7**	79·0	77·7	74·4
4	76·6	74·1	**72·6**	82·1	82·7	78·8	78·5	78·9	77·9	78·4	77·5	75·8
5	74·9	75·8	73·9	81·7	83·1	80·9	79·0	**78·7**	78·4	79·0	76·9	75·3
6	73·2	76·3	74·6	82·4	83·3	82·8	79·2	78·9	78·9	79·3	76·4	74·9
7	74·4	76·7	75·9	82·9	83·3	83·4	79·0	80·2	77·8	80·1	76·8	76·1
8	76·1	77·6	77·1	80·7	82·8	81·8	78·3	80·1	78·1	81·4	78·6	76·7
9	77·6	77·9	77·6	81·4	82·6	81·8	80·3	80·5	79·5	82·1	77·9	**77·9**
10	78·2	77·8	78·5	80·6	82·8	82·3	79·9	80·8	77·2	**82·7**	77·0	76·7
11	75·5	76·3	78·6	80·2	82·9	79·5	79·7	80·1	79·0	82·2	77·3	75·0
12	**72·3**	75·6	79·4	80·3	82·8	79·8	78·2	80·7	79·0	80·9	76·4	74·2
13	73·1	74·7	79·2	80·3	83·2	81·8	80·0	80·5	79·9	80·3	75·6	74·2
14	74·6	74·8	79·9	82·6	83·4	82·1	80·2	80·3	79·7	79·2	77·0	73·9
15	75·1	76·2	81·8	83·3	83·3	82·3	79·5	80·4	79·8	79·4	77·0	**73·4**
16	76·0	74·8	82·2	**84·1**	82·9	82·6	79·8	80·1	80·7	80·4	77·9	73·7
17	75·0	72·0	81·0	83·3	82·9	82·4	**77·8**	80·6	80·6	80·0	**78·7**	75·5
18	75·5	**71·7**	81·3	83·2	83·2	83·1	79·2	80·9	80·3	80·7	76·3	76·4
19	77·4	72·6	80·7	82·1	83·4	83·1	78·8	80·7	80·5	81·0	76·4	76·7
20	77·8	72·2	81·7	81·5	83·5	83·0	79·3	80·7	81·0	81·0	78·1	77·4
21	75·7	72·6	83·5	80·8	83·4	82·9	79·3	80·3	81·2	80·5	77·4	76·2
22	75·9	72·6	83·4	**80·1**	83·9	83·7	79·7	80·7	81·2	80·9	76·8	75·4
23	76·6	72·6	82·1	80·5	84·4	82·4	79·6	80·8	80·3	80·8	75·1	75·9
24	76·7	73·4	82·8	80·9	84·1	82·8	80·1	80·7	79·8	80·2	**74·9**	76·4
25	76·9	77·5	82·2	81·8	84·1	80·8	80·0	80·9	80·2	80·8	75·3	76·2
26	76·1	**79·2**	82·1	82·1	84·1	81·5	80·1	79·7	80·1	80·7	76·4	75·6
27	76·0	76·8	**84·4**	82·6	84·3	81·8	78·3	81·2	79·6	79·1	76·5	75·8
28	75·1	74·8	81·4	83·1	84·9	82·2	79·9	80·9	79·9	78·1	77·5	74·9
29	75·0		78·8	82·7	**85·6**	81·9	**80·8**	**81·3**	80·9	77·9	78·7	74·9
30	75·2		81·1	82·9	85·3	82·2	80·5	80·5	**81·5**	**77·5**	78·0	74·6
31	74·3		84·4		85·1		79·9	80·6		77·6		75·8
Monthly Mean..	75·8	**74·9**	79·5	82·0	**83·6**	81·8	79·3	80·3	79·6	80·1	77·0	75·7
Annual Variation ...	— 3·3	—4·2	+0·4	+2·9	+4·5	+2·7	+0·2	+1·2	+0·5	+1·0	—2·1	—3·4

	°
The greatest mean daily temperature of the air in the year (that of 29th May) was	85·6
The least do. do. do. (that of 18th February) was ...	71·7
Difference =	13·9

Table XXVII.—Pressure of Vapour, 1882.

1882. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·587	0·593	0·612	**0·953**	0·814	0·885	0·862	0·838	0·860	0·946	0·625	**0·761**
2	·612	·553	·610	·879	·754	**·862**	·876	·836	·863	·906	·707	·618
3	·645	·528	**·481**	·762	**·730**	·870	·867	·840	·846	·832	·752	·639
4	·608	·592	·510	·750	·768	·908	·874	·841	·862	·811	·721	·643
5	**·515**	·611	·575	·749	·802	·920	·893	·838	·872	·818	·679	·636
6	·523	·653	·605	·785	·791	**1·007**	**·897**	·835	·880	·827	·656	·631
7	·601	·730	·693	·773	·778	0·980	·890	·862	·870	·827	·656	·571
8	·651	**·753**	·707	·820	·812	·925	·877	·872	·864	·897	·660	·632
9	·704	·720	·769	·808	·850	·938	·891	**·876**	·880	**·948**	·686	·680
10	**·756**	·709	·770	·726	·850	·941	·879	·875	·850	·932	·722	·693
11	·709	·680	·741	·738	·864	·910	·868	·859	·876	·856	·701	·641
12	·523	·642	·773	·757	·858	·876	·863	·864	·850	·789	·671	·622
13	·521	·642	·825	·792	·838	·941	·886	·852	·849	·823	·639	·671
14	·575	·665	·807	·800	·829	·946	·886	·844	·837	·866	·592	·667
15	·572	·701	·705	·852	·833	·932	·884	·847	·833	·884	·612	·652
16	·596	·616	·726	·839	·839	·926	·873	·833	·826	·886	·649	·645
17	·618	·476	·714	·795	·841	·918	·865	·839	**·809**	·864	·632	·675
18	·600	**·435**	·676	·747	·867	·918	·875	·835	·827	·809	·679	·643
19	·640	·490	·808	·784	·871	·900	·865	·829	·831	·814	·695	·646
20	·546	·437	·716	·822	·878	·872	·864	·831	·823	·786	·660	·634
21	·595	·460	·782	·781	·850	·864	·857	·816	·831	·826	·660	·639
22	·653	·553	**·901**	**·679**	·838	·877	·865	·805	·864	·869	·598	·630
23	·628	·510	·874	·734	·828	·878	·866	·807	·898	·843	·543	·619
24	·614	·484	·800	·773	·859	·902	·875	·821	·890	·802	**·491**	·653
25	·607	·610	·825	·825	·861	·873	·863	·805	·884	·792	·527	·657
26	·591	·603	·823	·859	·846	·889	·855	**·804**	·871	·717	·642	·632
27	·609	·608	·723	·869	·870	·893	**·823**	·818	·860	·676	·707	·632
28	·618	·674	·679	·884	·901	·891	·856	·839	·857	·664	·808	·597
29	·618		·743	·883	**·925**	·889	·859	·852	·891	**·643**	**·827**	**·548**
30	·648		·708	·862	·903	·894	·843	·862	**·939**	·667	·813	·604
31	·633		·668		·895		·831	·856		·662		·639
Monthly Mean	0·610	**0·597**	0·721	0·803	0·840	**0·908**	0·869	0·840	0·860	0·816	0·667	0·640
Annual Variation ...	−0·154	−0·167	−0·043	+0·039	+0·076	+0·144	+0·105	+0·076	+0·096	+0·052	−0·097	−0·124

	in.
The greatest mean daily pressure of vapour in the year (that of 6th June) was	1·007
The least do. do. do. (that of 18th February) was	0·435
Difference =	0·572

TABLE XXVIII.—Additional Capacity of the Air, 1882.

1882. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	MONTH.											
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·425	0·266	0·236	0·188	0·354	0·312	0·095	0·150	0·153	0·156	0·306	0·187
2	·348	·292	·253	·243	·383	·101	·081	·168	·109	·130	·219	·333
3	·284	·282	·335	·373	·365	·076	·093	·199	·071	·160	·201	·214
4	·310	·257	·297	·351	·353	·076	·099	·146	·093	·166	·227	·255
5	·352	·292	·266	·339	·335	·137	·098	·144	·100	·174	·249	·245
6	·300	·259	·255	·326	·352	·114	·099	·152	·109	·175	·258	·241
7	·255	·193	·206	·358	·366	·164	·101	·168	·083	·204	·273	·342
8	·256	·199	·227	·230	·312	·162	·093	·157	·097	·178	·324	·295
9	·247	·240	·183	·267	·267	·151	·143	·167	·128	·151	·273	·284
10	·214	·248	·210	·322	·275	·164	·141	·177	·085	·189	·209	·231
11	·177	·229	·240	·297	·264	·099	·146	·169	·115	·247	·241	·233
12	·272	·246	·236	·280	·266	·143	·103	·184	·141	·268	·242	·229
13	·302	·221	·174	·246	·301	·149	·140	·189	·175	·211	·253	·179
14	·290	·200	·217	·322	·317	·150	·145	·191	·178	·134	·346	·173
15	·310	·206	·385	·293	·310	·170	·125	·189	·185	·124	·325	·172
16	·309	·249	·379	·335	·288	·188	·143	·193	·222	·153	·315	·190
17	·254	·312	·349	·351	·285	·187	·092	·205	·237	·163	·352	·215
18	·291	·349	·399	·396	·272	·216	·123	·220	·208	·243	·230	·271
19	·308	·318	·242	·316	·275	·234	·121	·214	·211	·248	·220	·277
20	·419	·358	·369	·256	·272	·258	·137	·220	·236	·276	·312	·315
21	·300	·350	·369	·274	·296	·261	·143	·217	·235	·217	·286	·270
22	·249	·252	·244	·352	·328	·242	·148	·243	·202	·195	·329	·256
23	·295	·296	·223	·309	·356	·230	·143	·246	·139	·213	·329	·279
24	·315	·348	·328	·284	·314	·222	·152	·229	·131	·232	·380	·264
25	·324	·356	·280	·265	·312	·178	·162	·250	·150	·264	·353	·254
26	·317	·412	·277	·242	·326	·189	·174	·210	·156	·341	·268	·258
27	·293	·320	·466	·250	·308	·196	·145	·249	·151	·325	·210	·268
28	·257	·190	·400	·253	·301	·209	·165	·215	·165	·307	·137	·273
29	·257		·247	·237	·303	·202	·193	·219	·166	·322	·156	·323
30	·230		·363	·267	·314	·206	·197	·179	·138	·283	·146	·260
31	·221		·521		·316		·189	·189		·290		·259
Monthly Mean.	0·290	0·276	0·296	0·294	0·313	0·179	0·133	0·195	0·152	0·217	0·266	0·253
Annual Variation ...	+0·051	+0·037	+0·057	+0·055	+0·074	−0·060	−0·106	−0·044	−0·087	−0·022	+0·027	+0·014

	in.
The greatest mean daily additional capacity of the air in the year (that of 31st March) was...	0·521
The least do. do. do. do. (that of 3rd September) was ...	0·071
Difference =	0·450

Rainfall, 1882.

TABLE XXIX.—*Total Fall of Rain (in inches) as measured by F. Chambers's Self-registering Gauge, the funnel of which is 28 feet above the ground.*

1882. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	
1				0·06			1·77	0·46	0·42			
2				0·01		3·51	1·76	0·04	1·11	0·10		
3						**9·26**	2·29	0·08	0·72	0·24 }		
4						2·94	1·10	0·38	0·63	0·74 }		
5						0·74	0·89	**0·48**	1·18			
6						0·15	0·96	0·22	1·62			
7						0·01	0·69	0·03	**2·66**			
8						0·62	3·42	0·01	0·21			
9							0·59		0·17 }			
10						0·13	0·65	0·10	0·75 }			
11						3·45	0·29	0·14	0·14 }			
12						0·59	1·94	0·03	0·04			
13						0·48	0·22	0·12				
14						0·48	0·06	0·13				
15						0·07	0·55	0·06				
16		0·03				0·19	0·17	0·08				
17						0·21	**5·08**					
18							0·12					
19							0·75					
20							0·73	0·03	0·01			
21							0·12	0·01				
22						0·14	0·18	0·02	0·02			
23			0·01			0·26	0·02		0·11			
24							0·01	0·16				
25						0·81	0·03					
26						0·02	0·11	0·08				
27						0·33	0·38		0·01			
28						0·29	0·34	0·16			0·01	
29						0·24						
30						0·07	0·03	0·17				
31					0·01		0·36	0·14				
Monthly Total.		0·03	0·01	0·07	0·01	24·99	**25·61**	3·13	9·80	1·08	0·01	
Number of rainy days...		1	1	2	1	23	**30**	23	16	3	1	

Total fall of rain in the year ... ...64·74 inches.

Total number of rainy days in the year 101

The greatest daily fall of rain in the year (that of 3rd June) was ... ...9·26 inches.

No rain fell in the months of January and December, nor on any of the days left blank in the above table.

The entries for September 9, 10 and 11, and those for October 3 and 4, bracketed together, are correct in the aggregate but only approximate in the distribution.

Mean Daily Velocities o the North and East Components of the Wind, 1882.

TABLE XXX.—*Showing the Mean Velocities of the North or South and East or West Components of the Winds which blew on each Day of the Year* 1882.

In Miles per Hour.

1882.	MONTH.																							
Date.	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.	N. or S.	E. or W.
1 ...	7·8 N	5·3 E	11·8 N	2·6 W	7·5 N	4·1 W	6·0 S	4·6 W	6·3 N	5·7 W	24·8 S	8·2 E	0·7 N	7·8 W	1·4 N	13·9 W	0·3 N	1·9 W	3·0 N	5·0 W	5·7 N	1·2 W	7·7 N	3·5 W
2 ...	7·5 N	0·3 E	13·6 N	5·7 W	8·0 N	3·4 W	0·7 N	5·4 W	4·3 N	5·6 W	25·1 S	10·2 E	4·0 S	1·6 W	3·2 S	15·0 W	5·8 S	2·9 E	4·7 N	5·4 W	0·2 N	0·2 E	8·1 N	0·8 W
3 ...	7·1 N	2·1 W	9·6 N	2·1 W	10·6 N	5·5 W	11·5 N	6·1 W	0·4 S	6·8 W	0·2 S	24·5 W	4·3 S	8·5 W	4·0 S	12·5 W	0·0	1·8 W	10·9 S	2·7 W	0·5 N	0·1 E	6·8 N	4·0 W
4 ...	10·5 N	2·8 W	10·0 N	1·0 W	5·5 N	3·4 W	8·9 N	6·7 W	6·6 S	4·5 W	7·2 S	6·9 W	6·5 S	16·2 W	5·9 S	16·6 W	0·6 S	13·2 W	7·5 S	2·2 E	5·9 N	1·8 W	3·4 N	0·9 W
5 ...	9·2 S	2·5 W	7·0 N	1·6 W	2·1 N	2·9 W	10·1 N	6·1 W	6·4 S	5·2 W	0·7 S	10·4 W	6·8 S	12·6 W	9·9 S	16·7 W	0·8 N	9·0 W	1·8 S	0·3 E	6·9 N	2·0 W	3·4 N	1·1 E
6 ...	7·6 N	0·8 W	0·6 S	0·6 E	7·4 N	4·5 W	13·6 N	7·1 W	3·2 S	7·8 W	0·1 N	9·8 W	12·7 S	20·9 W	9·4 S	22·7 W	0·8 S	9·6 W	7·1 N	3·6 W	8·1 N	2·0 W	5·5 N	2·0 E
7 ...	9·3 N	2·9 W	0·4 N	0·2 W	6·7 N	5·9 W	11·1 N	7·0 W	1·5 S	7·5 W	3·1 S	9·6 W	13·1 S	20·7 W	8·3 S	17·2 W	0·3 S	8·3 W	6·3 N	0·1 W	7·0 N	3·5 W	6·0 N	4·5 E
8 ...	7·7 N	1·6 W	1·0 N	0·3 W	5·5 N	5·6 W	9·1 N	7·7 W	7·0 N	9·9 W	7·4 S	5·8 W	10·1 S	22·4 W	6·0 S	17·7 W	1·9 N	9·6 W	2·2 N	1·4 W	7·0 N	0·6 E	5·5 N	4·0 E
9 ...	5·4 N	0·7 W	2·1 N	1·9 W	1·0 N	4·4 W	5·7 N	7·3 W	8·5 N	8·7 W	19·4 S	4·6 E	9·6 S	23·2 W	1·8 N	10·9 W	1·7 N	16·6 W	0·2 S	1·8 W	4·8 N	1·2 E	3·8 N	2·1 E
10 ...	0·1 S	0·4 W	7·7 N	3·9 W	0·7 N	1·3 W	4·8 N	5·2 W	4·0 N	6·3 W	16·6 S	1·1 E	8·8 S	21·2 W	0·3 S	8·5 W	1·9 S	13·0 W	5·1 N	2·4 W	5·4 N	0·3 W	4·7 N	1·5 E
11 ...	5·2 N	2·0 W	10·6 N	4·3 W	7·1 N	2·8 W	1·4 N	5·3 W	3·2 N	7·8 W	7·6 S	21·4 W	10·1 S	24·3 W	0·0	7·8 W	2·5 S	19·0 W	8·6 N	2·4 W	4·4 N	0·7 W	5·6 N	0·1 W
12 ...	13·9 N	2·0 W	6·6 N	2·0 W	0·4 N	3·8 W	2·8 N	7·0 W	5·0 N	8·5 W	9·8 S	26·1 W	8·9 S	28·6 W	3·3 S	12·4 W	5·5 S	15·3 W	9·3 N	2·5 W	5·3 N	0·2 W	6·1 N	1·1 W
13 ...	11·8 N	0·4 W	7·2 N	0·4 W	4·6 S	3·6 W	3·7 N	4·4 W	3·1 N	7·6 W	3·7 S	26·3 W	7·2 S	20·2 W	5·5 S	17·5 W	3·2 S	8·6 W	4·3 N	1·7 W	5·9 N	0·6 W	7·6 N	3·6 W
14 ...	7·8 N	0·7 W	9·7 N	4·0 W	0·7 S	1·7 W	7·0 N	4·3 W	0·8 N	8·4 W	1·7 S	19·6 W	8·0 S	21·1 W	2·2 S	18·8 W	2·8 S	2·9 W	1·6 S	1·6 W	5·1 N	2·6 E	9·4 N	2·4 W
15 ...	6·5 N	0·2 W	2·3 N	0·1 W	10·6 N	4·2 W	0·9 S	2·6 W	6·7 N	10·0 W	4·7 S	20·3 W	3·6 S	20·5 W	8·3 S	21·7 W	0·0	3·4 W	4·0 S	1·4 W	6·0 N	6·0 E	11·9 N	3·0 W
16 ...	4·3 N	1·1 E	11·6 N	4·4 W	13·6 N	6·9 W	4·0 N	5·3 W	8·1 N	8·0 W	2·0 S	20·0 W	8·1 S	20·7 W	1·4 S	19·1 W	4·5 N	5·1 W	1·8 S	0·8 W	9·3 N	2·5 E	6·9 N	1·9 W
17 ...	8·0 N	1·6 W	17·9 N	4·8 W	12·3 N	4·0 W	3·9 N	5·0 W	6·6 N	9·8 W	2·5 S	18·4 W	11·1 S	21·2 W	2·1 N	14·7 W	1·5 N	6·1 W	3·7 N	2·6 W	7·0 N	1·4 E	3·1 N	0·3 E
18 ...	6·1 N	0·6 W	12·4 N	3·9 W	5·7 N	2·1 W	10·5 N	7·5 W	5·6 N	10·2 W	5·2 S	15·9 W	9·8 S	26·3 W	3·0 N	13·4 W	0·1 S	6·6 W	9·2 N	2·1 W	6·3 N	2·0 W	7·4 N	0·5 E
19 ...	7·2 N	1·5 E	8·1 N	3·1 W	0·1 N	4·1 W	10·8 N	8·3 W	7·5 N	11·7 W	4·9 S	21·7 W	6·7 S	29·0 W	0·3 N	11·6 W	0·8 N	0·9 W	8·3 N	0·2 W	6·9 N	2·0 W	6·6 N	1·3 E
20 ...	8·4 N	4·6 E	13·3 N	1·3 W	13·7 N	6·0 W	8·8 N	7·7 W	4·4 N	10·0 W	4·3 S	9·9 W	1·3 S	27·3 W	2·2 N	11·7 W	5·5 N	2·6 W	7·4 N	3·3 W	6·5 N	1·7 E	7·3 N	2·3 E
21 ...	6·3 N	0·7 E	6·9 N	3·4 W	11·1 N	5·1 W	1·4 N	4·8 W	2·0 N	8·8 W	5·3 S	9·0 W	7·3 S	26·1 W	3·3 N	9·7 W	8·2 N	2·2 W	6·7 N	2·8 W	4·9 N	0·6 E	1·3 N	0·6 E
22 ...	3·7 N	1·4 E	6·1 N	3·8 W	8·3 S	2·5 W	4·9 N	8·3 W	3·5 N	9·4 W	9·4 S	12·3 W	9·8 S	17·7 W	1·3 N	8·9 W	9·1 N	3·9 W	5·2 N	2·1 W	8·8 N	4·3 E	4·7 N	1·3 E
23 ...	3·6 N	1·6 E	9·0 N	0·2 W	0·5 N	4·4 W	4·4 N	7·9 W	5·7 N	9·1 W	11·1 S	15·4 W	7·8 S	15·7 W	0·5 N	9·2 W	4·8 N	0·0	1·8 N	0·2 W	8·5 N	5·2 E	3·4 N	0·8 E
24 ...	6·2 N	0·3 E	10·6 N	2·8 W	6·6 N	4·3 W	1·8 N	5·8 W	5·8 N	9·5 W	7·6 S	17·2 W	5·2 S	15·1 W	1·2 N	7·4 W	2·4 N	0·6 W	1·0 N	0·1 W	10·1 N	4·0 E	2·7 N	1·6 E
25 ...	8·0 W	0·2 W	5·8 N	2·0 E	1·5 S	5·3 W	2·4 N	5·9 W	2·0 N	8·3 W	4·6 S	18·1 W	1·0 S	14·0 W	2·9 N	6·9 W	5·1 N	3·6 W	5·0 N	1·1 E	10·4 N	1·8 E	0·4 S	3·7 E
26 ...	10·1 N	1·3 W	5·3 N	2·3 E	4·4 N	4·0 W	2·3 S	3·9 W	3·6 N	7·2 W	0·2 S	16·5 W	5·0 S	18·4 W	0·7 N	11·4 W	6·1 N	6·2 W	6·3 N	3·7 E	10·3 N	2·1 E	2·2 N	1·0 E
27 ...	9·2 N	1·7 W	8·6 N	4·7 W	14·2 N	6·4 W	3·2 S	4·7 W	4·2 N	7·4 W	1·4 S	12·6 W	1·6 S	17·1 W	3·8 S	8·2 W	0·0	1·3 W	6·7 N	3·2 E	7·9 N	1·9 E	6·4 N	3·1 E
28 ...	12·2 N	2·9 W	6·9 N	3·9 W	13·2 N	5·3 W	4·3 S	5·6 W	10·7 N	9·8 W	1·2 S	14·0 W	2·9 S	16·9 W	1·9 S	7·1 W	0·3 S	0·5 W	7·6 N	1·7 E	2·8 N	0·5 E	3·1 N	0·1 E
29 ...	8·4 N	1·4 W			9·8 N	5·9 W	0·0	5·9 W	5·0 N	9·7 W	0·3 N	12·5 W	0·3 S	10·8 W	1·2 S	3·4 W	4·7 N	4·6 W	5·8 N	1·9 E	3·8 N	1·1 W	2·7 N	1·3 E
30 ...	7·4 N	2·6 W			15·5 N	4·0 W	5·5 N	7·9 W	3·3 N	6·8 W	0·8 N	15·3 W	1·7 N	10·1 W	5·3 N	5·1 W	1·0 N	4·0 W	5·1 N	0·5 W	4·7 N	2·2 W	3·5 N	2·0 E
31 ...	7·5 N	3·4 W			10·4 N	4·8 W			5·0 S	1·5 W			0·4 S	12·5 W	1·9 N	4·2 W			8·7 N	1·4 W			5·2 N	1·5 E
Monthly Mean ...	7·5 N	0·6 W	7·9 N	2·2 W	6·1 N	4·3 W	4·4 N	6·0 W	3·4 N	7·9 W	6·4 S	12·5 W	6·1 S	18·3 W	1·5 S	12·3 W	1·2 N	5·7 W	3·6 N	1·1 W	6·2 N	0·6 E	5·2 N	0·5 E
Annual Variation ...	4·9 N	5·2 E	5·3 N	3·6 E	3·5 N	1·5 E	1·8 N	0·2 W	0·8 N	2·1 W	9·0 S	6·7 W	8·7 S	12·5 W	4·1 S	6·5 W	1·4 S	0·1 E	1·0 N	4·7 E	3·6 N	6·4 E	2·6 N	6·3 E

The Velocities of the Mean Components for the year are 2·6 N. and 5·8 W.

Velocity of Wind, 1882.

TABLE XXXI.—*Mean Velocity of the Wind, in miles per hour, without regard to the direction from which it blew, for each day of Bombay Civil Time: also the Mean Monthly Velocity, and its variation from the Mean of the year.*

1882.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
1	13·7	13·3	10·4	10·0	9·8	27·4	10·6	14·5	7·8	6·5	9·1	9·8
2	10·9	15·2	10·4	7·2	11·2	**34·2**	**9·8**	15·7	9·5	8·6	**5·6**	9·0
3	8·5	11·2	12·8	13·5	**7·8**	28·8	12·6	13·3	9·1	**12·3**	7·6	8·4
4	11·1	12·0	9·0	13·6	10·7	17·1	18·4	17·9	13·4	11·3	8·8	6·5
5	11·2	8·8	7·0	14·1	9·2	13·2	14·7	19·8	9·5	8·0	10·5	7·5
6	9·1	**5·6**	10·0	**16·8**	8·9	**10·1**	25·0	**24·6**	9·9	9·5	9·8	10·2
7	10·9	6·1	9·8	13·9	8·1	11·1	25·1	19·3	8·7	9·7	9·4	11·1
8	10·3	5·6	8·5	12·7	12·4	12·2	25·2	18·9	11·5	6·3	9·5	10·2
9	8·0	6·0	**5·6**	11·0	13·5	21·6	25·2	11·4,	16·9	6·2	8·7	8·4
10	**7·9**	10·1	6·8	8·5	10·2	20·6	23·0	8·7	14·2	8·1	8·5	8·0
11	8·7	12·4	10·5	**7·0**	8·5	24·1	26·3	8·2	**19·5**	10·1	7·9	8·8
12	**14·7**	12·7	7·5	8·2	10·0	28·5	30·3	13·1	16·4	10·5	8·1	7·8
13	13·5	11·4	8·0	9·1	9·5	27·0	21·6	18·8	9·6	8·0	8·7	9·0
14	10·2	12·8	6·6	10·8	8·7	20·0	22·7	19·2	7·4	**5·2**	10·0	10·6
15	8·7	6·9	13·0	8·7	12·3	21·2	21·2	23·4	6·1	6·7	12·8	**12·7**
16	8·0	13·6	15·7	8·0	13·1	20·4	22·4	19·6	8·1	7·8	12·2	8·4
17	9·4	**19·0**	13·7	8·7	12·4	18·9	24·8	15·1	6·5	8·7	10·5	6·9
18	7·9	13·7	9·0	13·7	12·2	16·9	28·3	14·0	6·7	10·5	8·4	10·4
19	12·0	10·1	7·8	14·2	14·3	12·7	**30·4**	11·7	7·2	9·8	8·6	11·0
20	12·7	15·1	15·5	12·4	11·3	10·8	27·5	12·2	8·8	8·9	9·6	10·8
21	9·7	9·0	16·1	7·1	9·2	10·6	27·6	10·7	11·0	9·4	9·2	7·3
22	8·0	9·4	11·5	10·1	8·4	15·9	20·6	9·1	10·7	7·2	13·2	8·7
23	8·1	13·1	6·2	9·2	11·1	19·5	17·9	9·4	9·0	7·2	**13·7**	6·4
24	8·7	11·7	10·8	7·3	11·7	18·9	16·1	8·2	7·7	6·1	13·1	7·6
25	9·6	9·6	6·6	9·4	8·7	19·6	14·3	7·8	7·7	9·9	13·1	9·0
26	11·0	10·0	7·6	7·8	8·2	17·2	19·4	11·8	9·0	10·8	12·2	**5·9**
27	10·7	11·0	15·9	8·9	9·3	12·9	17·8	9·4	5·4	11·4	10·6	10·9
28	13·2	8·7	14·8	8·4	**14·9**	14·4	17·5	7·7	7·1	12·0	6·0	7·0
29	10·4		12·2	7·2	11·8	12·9	11·0	**6·5**	8·0	9·7	5·9	6·1
30	9·2		17·2	10·1	8·3	15·4	10·5	8·6	**4·5**	8·0	6·6	7·8
31	8·9		**18·2**		10·7		12·6	7·5		11·5		8·4
Monthly Mean	10·2	10·9	10·8	10·3	10·5	18·5	**20·3**	13·4	9·6	8·9	9·6	**8·7**
Annual Variation ...	—1·6	—0·9	—1·0	—1·5	—1·3	+6·7	+8·5	+1·6	—2·2	—2·9	—2·2	—3·1

	Miles.
The Mean Velocity for June to August	17·4
The Mean Velocity for September to May	9·9
The Mean Velocity for the year	11·8
The greatest monthly mean (that of July)	20·3
The least monthly mean (that of December)	8·7
Difference =	11·6

The greatest mean daily Velocity of Wind in the year (that of 2nd June) was ... ... 34·2
The least do. do. do. (that of 30th September) was ... ... 4·5

Difference = 29·7

Aggregate and Mean Velocities and Relative Frequency of Different Winds, 1882.

TABLE XXXII.—*Showing, for the year* 1882, *the sum of the Velocities, and the Mean Velocities, in miles per hour, of the Winds which blew in each Month, from each of the Sixteen Principal Directions; and also the number of Observations which those sums comprise; the latter numbers indicating the Relative Frequency of the same Wind (as to direction) in the several Months, and of different Winds during the same Month.*

1882.	N.			NNE.			NE.			ENE.			E.			ESE.			SE.			SSE.		
MONTH.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	1283	158	8·1	385	59	6·5	654	85	7·7	743	82	9·1	262	32	8·2	147	23	6·4	0	0	...	0	0	...
February ...	893	96	9·3	475	65	7·3	323	44	7·3	409	43	9·5	136	24	5·7	253	41	6·2	21	3	7·0	11	3	3·7
March ...	482	55	8·8	267	41	6·5	194	24	8·1	56	6	9·3	150	25	6·0	131	21	6·2	63	11	5·7	45	7	6·4
April ...	280	38	7·4	231	37	6·2	51	8	6·4	9	1	9·0	30	5	6·0	145	24	6·0	82	14	5·9	91	13	7·0
May ...	36	7	5·1	216	32	6·7	13	2	6·5	0	0	...	0	0	...	48	3	16·0	99	6	16·5	0	0	...
June ...	9	2	4·5	27	2	13·5	0	0	...	3	1	3·0	0	0	...	44	4	11·0	871	35	24·9	662	26	25·5
July ...	0	0	...	0	0	...	0	0	...	3	1	3·0	0	0	...	37	4	9·2	45	4	11·2	56	3	18·7
August ...	5	1	5·0	12	2	6·0	7	1	7·0	32	4	8·0	10	2	5·0	0	0	...	41	6	6·8	8	2	4·0
September ...	84	14	6·0	112	20	5·6	175	27	6·5	112	14	8·0	51	8	6·4	414	44	9·4	113	16	7·1	124	12	10·3
October ...	437	63	6·9	255	44	5·8	206	30	6·9	701	73	9·6	187	29	6·4	336	42	8·0	180	22	8·2	168	25	6·7
November ...	395	64	6·2	487	67	7·3	1132	117	9·7	1061	102	10·4	233	30	7·8	134	25	5·4	63	9	7·0	11	2	5·5
December ...	676	100	6·8	285	52	5·5	585	81	7·2	1178	126	9·3	428	59	7·3	211	24	8·8	33	4	8·2	0	0	...
Year ..	4580	598	7·7	2752	421	6·5	3340	419	8·0	4307	453	9·5	1487	214	6·9	1900	255	7·5	1611	130	12·4	1176	93	12·6

1882.	S.			SSW.			SW.			WSW.			W.			WNW.			NW.			NNW.		
Month.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.	Sum of Velocities.	Number of Observations.	Mean Velocity.
	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.	Miles.		Miles.
January ...	0	0	...	0	0	...	11	2	5·5	33	3	11·0	27	4	6·7	313	29	10·8	1110	97	11·4	2594	170	15·3
February ...	0	0	...	5	1	5·0	4	1	4·0	37	5	7·4	54	10	5·4	335	41	8·2	1811	137	13·2	2534	157	16·1
March ...	280	24	11·7	172	19	9·1	122	18	6·8	191	21	9·1	221	26	8·5	687	76	9·0	2192	186	11·8	2786	183	15·2
April ...	88	9	9·8	139	23	6·0	133	19	7·0	374	40	9·3	702	71	9·9	1513	138	11·0	2477	205	12·1	1037	71	14·6
May ...	66	6	11·0	123	14	8·8	322	38	8·5	397	45	8·8	1188	132	9·0	2948	258	11·4	1975	157	12·6	407	44	9·2
June ...	760	28	27·1	356	18	19·8	1022	65	15·7	4909	264	18·6	3938	229	17·2	543	35	15·5	124	7	17·7	33	4	8·2
July ...	70	8	8·7	81	5	16·2	1178	61	19·3	9459	416	22·8	3855	209	18·4	256	21	12·2	57	7	8·1	36	5	7·2
August ...	6	1	6·0	0	0	...	407	32	12·7	4137	231	17·9	3496	288	12·1	1643	156	10·5	171	16	10·7	9	2	4·5
September ...	47	6	7·8	56	9	6·2	193	21	9·2	954	76	12·6	1938	168	11·5	1185	131	9·0	1109	131	8·5	217	22	9·9
October ...	149	16	9·3	302	32	9·4	88	10	8·8	161	23	7·0	132	22	6·0	365	40	9·1	1470	147	10·0	1489	126	11·8
November ...	15	3	5·0	15	4	3·7	0	0	...	24	3	8·0	30	4	7·5	460	54	8·5	1196	103	11·6	1658	133	12·5
December ...	0	0	...	2	1	2·0	0	0	...	30	5	6·0	179	24	7·5	491	63	7·8	974	92	10·6	1428	112	12·7
Year ...	1481	101	14·7	1251	126	9·9	3480	267	13·0	20706	1132	18·3	15760	1187	13·3	10739	1042	10·3	14666	1285	11·4	14228	1029	13·8

Extent of cloudy Sky, 1879.

TABLE XXXIII.—*Means of estimations made at* 6, 10, 14, 16 *and* 22 *hours daily, the whole Sky being reckoned as* 8.

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December
						MONTH.						
1	4·6			1·4	6·2	**8·0**	**8·0**	**8·0**	7·8	5·6	4·2	
2	0·6	2·6	3·4		0·8	6·8	8·0	8·0	**8·0**	5·0	3·8	
3		4·2	2·4		0·8	4·2	8·0	8·0	7·2	**7·6**	**5·0**	
4	0·8	2·4	1·2	1·0	0·4	5·4	8·0	8·0	7·0	6·8	0·4	0·8
5	2·6	2·4	2·2	2·0	1·0	3·2	7·8	8·0	7·2	6·2	0·4	1·2
6	**5·6**			2·0	4·4	5·0	7·6	8·0	7·6	7·2	0·4	2·4
7	2·6	2·0		1·2		3·8	7·4	8·0	6·0	7·4		0·2
8		0·4		**2·4**	1·4	3·8	6·8	8·0	5·6	4·0		3·0
9		0·4	0·2	0·4	2·0	**2·0**	6·8	8·0	7·0	3·4		
10		3·0	0·6		1·6	5·2	7·6	8·0	6·2	3·6		
11		2·4			2·0	7·2	7·2	8·0	6·4	2·8		1·6
12		0·8	0·2		0·2	5·2	7·6	8·0	6·2	1·2		
13	0·8				3·6	7·4	7·8	8·0	7·0	0·6		
14	1·2	0·8			4·2	6·8	6·8	8·0	4·8	1·8		
15		1·8	1·6	0·8	2·4	6·0	6·4	8·0	4·6	1·8		0·4
16				1·0	4·0	6·4	6·2	8·0	4·2	3·2	0·8	**7·6**
17		1·6			7·8	8·0	6·4	8·0	**3·6**	3·0		4·8
18		**5·4**	4·8		6·0	7·2	8·0	7·0	4·4		1·2	0·4
19	3·0	3·4	1·8		5·6	7·4	7·0	8·0	5·4	1·2		
20		1·4		1·0	5·8	8·0	8·0	7·6	7·4	2·0	0·2	0·4
21		5·4		1·4	**8·0**	7·2	6·8	7·2	4·8	3·0	2·6	
22		0·2	1·6	1·2	7·6	7·8	8·0	7·8	4·0	2·6	0·8	
23	2·0	0·6	0·6	0·4	6·4	7·2	**4·4**	8·0	4·0	1·8	0·4	
24		2·2			7·6	7·6	6·8	8·0	3·6	1·6		
25	2·0	0·6	0·8	1·4	8·0	8·0	6·2	7·4	6·8	2·2		
26		0·8	3·6	1·0	7·6	7·8	7·8	7·4	7·4	3·2		
27		2·4	5·0	1·2	7·6	8·0	8·0	5·8	8·0	2·6		
28		4·2	**6·6**	0·6	7·6	8·0	4·6	**5·6**	4·6	0·4		
29			4·0	2·2	8·0	8·0	6·2	6·8	4·4	0·6		
30			3·6	2·0	8·0	7·4	8·0	6·2	4·0	6·0		
31			4·8		8·0		8·0	8·0		2·6		0·4
Monthly Mean.	0·8	1·8	1·6	0·8	4·7	6·5	7·2	**7·6**	5·8	3·3	**0·7**	0·7
Annual Variation. ...	—2·7	—1·7	—1·9	—2·7	+1·2	+3·0	+3·7	+4·1	+2·3	—0·2	—2·8	—2·8

For the days which have no entry 0·0 is to be understood.

Mean of the months from January to April, November and December ... ... 1·1

Mean of the months from May to October ... ... 5·8

Mean for the year... ... ... 3·5

Rainfall, 1879.

TABLE XXXIV.—*Total Fall of Rain (in inches) as measured by Newman's Gauge, placed 4½ feet above the ground.*

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
			in.		in.	in.	in.	in.	in.	in.		
1							0·64	0·52	0·33	0·09		
2						0·12	0·53	1·33	0·07			
3						0·08	0·05	1·57		0·06		
4						0·04	0·43	**2·53**	0·02			
5						0·20	0·15	1·72	0·02			
6						0·07	0·01	1·07	0·22			
7							0·01	0·03		0·25		
8								0·60				
9							0·01	0·83	0·02			
10						0·02	0·04	0·09	0·11			
11							0·03	0·19	0·01			
12						0·09		0·05				
13						1·60	0·10	0·17	0·39			
14						0·08	0·15	1·09	0·02			
15							0·18	0·72	0·04			
16						1·09	0·01	0·37	0·03			
17						1·88		0·59				
18						1·20	0·06	0·93				
19						1·39	0·33	0·85	0·28			
20						0·06		0·49	0·60			
21					0·20			0·24	**1·41**			
22					0·09	0·02	0·57	1·62				
23						0·22		0·56	0·49			
24					0·08	**3·73**	0·18	2·31				
25					0·76	2·15	0·02	0·17	0·04			
26			0·03		1·60	1·24		0·09				
27					0·47	0·64	0·08	0·25	0·46			
28					**1·85**	0·41		0·16	0·29			
29					0·16	0·07	0·38	0·44	0·31			
30					0·02	0·16	**3·78**	0·45	0·45			
31							3·47	0·33				
Monthly Total.			0·03		5·23	16·56	11·21	**22·36**	5·61	0·40		
Number of rainy days ...			1		9	23	23	**31**	21	3		

Total fall of rain in the year ... ... 61·40 inches.
Total number of rainy days in the year 111
The greatest daily fall of rain in the year (that of 30th July) was ... ... 3·78 inches.
No rain fell in the months of January, February, April, November and December, nor on any of the days left blank in the above table.

Rainfall, 1879.

TABLE XXXV.—*Total Fall of Rain (in inches) as measured by Osler's Gauge, placed 46 feet above the ground.*

1879. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
			in.		in.	in.	in.	in.	in.	in.		
1							0·49	0·45	0·24	0·09		
2						0·09	0·45	1·15	0·05			
3						0·05	0·04	1·40		·003		
4						0·04	0·34	2·22	0·01			
5						0·15	0·12	1·49	0·01			
6						0·06	0·01	0·88	0·17			
7							0·01	0·03		0·21		
8								0·51				
9							0·01	0·67				
10							0·03	0·07	0·09			
11							0·03	0·16				
12						0·07		0·04				
13						1·43	0·07	0·11	0·34			
14						0·06	0·12	0·86	0·01			
15							0·14	0·58	0·03			
16						1·05	0·01	0·28	0·02			
17						1·72		0·50				
18						1·11	0·05	0·80				
19						1·33	0·32	0·73	0·25			
20						0·06		0·43	0·52			
21					0·19			0·23	1·32			
22					0·08	0·01	0·54	1·44				
23						0·16		0·47	0·43			
24						3·58	0·15	2·07				
25					0·34	1·85	0·01	0·12	0·03			
26			0·02		1·41	1·09		0·07				
27					0·41	0·50	0·06	0·21	0·40			
28					1·76	0·31		0·12	0·26			
29					0·13	0·05	0·30	0·40	0·27			
30					0·01	0·12	3·37	0·39	0·41			
31							3·17	0·26				
Monthly Total			0·02		4·33	14·89	9·84	19·14	4·86	0·33		
Number of rainy days... ...			1		8	22	23	31	19	3		

Total fall of rain in the year ... ... 53·41 inches.
Total number of rainy days in the year 107
The greatest daily fall of rain in the year (that of 24th June) was ... ... 3·58 inches.
No rain fell in the months of January, February, April, November and December, nor on any of the days left blank in the above table.

Extent of Cloudy Sky, 1880.

TABLE XXXVI.—*Means of estimations made at* 6, 10, 14, 16 *and* 22 *hours daily, the whole Sky being reckoned as* 8.

1880. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	3·0	0·6	1·0	0·6		6·0	**8·0**	7·8	6·0	3·6	0·6	3·2
2	2·4		0·8		0·6	**3·4**	8·0	6·2	4·4	3·8	0·4	0·4
3			0·2	0·4	2·2	7·0	8·0	6·2	5·8	4·8	0·4	0·6
4			4·6		2·6	4·2	8·0	7·4	7·4	5·2		2·0
5			3·0	0·6	2·2	6·6	8·0	7·4	4·8	3·6		2·8
6	0·2		3·4	1·8	0·8	7·6	7·4	7·6	6·4	1·8	0·4	**3·6**
7		2·2	**7·2**	1·0	0·6	6·0	8·0	7·6	7·8	2·4	0·2	1·4
8			6·2	1·2	0·6	4·8	**4·2**	7·2	5·0	5·6	1·0	1·4
9			4·6	0·6	1·4	3·6	6·4	6·8	6·0	5·2	5·8	
10			3·0	1·2	1·4	4·8	6·2	**8·0**	6·6	2·0	5·2	
11	0·8		3·0	2·4	0·8	4·6	7·0	6·8	7·4	2·4	6·4	
12	0·2		3·6	**7·2**	1·2	4·2	7·6	6·6	**8·0**	0·2	3·2	
13	0·2		3·2	7·0	1·6	5·8	8·0	7·8	7·2	4·4	3·4	0·4
14		2·2	1·8	3·2	2·8	6·2	7·8	7·8	8·0	3·4	2·8	0·8
15		3·2		1·0	1·4	6·0	7·8	7·8	7·6	5·2	3·8	2·0
16	0·2	**3·8**	0·4	0·6	2·6	5·2	8·0	7·8	8·0	0·2	1·4	
17		2·6	1·0	0·4	1·6	5·4	5·8	5·6	7·8		1·8	
18			2·4	0·4	3·2	4·0	6·2	6·0	7·8	2·4	3·6	
19			1·6	2·8	3·0	4·0	7·0	7·4	6·8	5·4	0·4	0·2
20	2·2	0·6	1·4	2·4	4·4	3·6	6·6	4·2	7·4	5·0	2·4	2·8
21		3·2	2·0	1·4	2·8	6·4	8·0	3·0	7·0	5·6	4·2	2·8
22	0·8		2·0	3·2	4·4	5·4	8·0	7·6	7·4	5·4	4·6	1·6
23			4·2	1·6	3·4	6·6	7·4	7·2	4·8	5·8	**6·6**	0·2
24			3·2	1·2	4·8	**8·0**	8·0	**2·8**	4·4	3·0	6·0	
25		1·2	5·6	3·2	3·8	8·0	7·4	3·8	6·4	1·4	6·6	
26	0·8	2·6	3·6	0·6	3·0	8·0	7·4	3·4	6·4	1·2	5·6	1·6
27	2·2		0·6	3·4	4·4	8·0	7·8	6·0	6·0	3·4	0·8	
28	3·6		3·4	3·8	3·6	8·0	7·8	4·6	5·8	4·6	1·6	
29	1·2		1·2	2·4	3·0	8·0	8·0	4·6	4·0	3·0	1·4	3·6
30	**5·2**		2·2	1·4	4·4	8·0	7·4	4·8	**3·0**	**6·0**	1·0	2·2
31	0·8		0·2		**5·2**		7·4	7·2		1·4		3·4
Monthly Mean...	**0·8**	0·8	2·6	1·9	2·5	5·9	**7·4**	6·3	6·4	3·5	2·7	1·2
Annual Variation ...	−2·7	−2·7	−0·9	−1·6	−1·0	+2·4	+3·9	+2·8	+2·9	0·0	−0·8	−2·3

For the days which have no entry 0·0 is to be understood.

Mean of the months from January to April, November and December ... ... 1·7

Mean of the months from May to October ... ... 5·3

Mean for the year ... ... 3·5

Rainfall, 1880.

TABLE XXXVII.—*Total Fall of Rain (in inches) as measured by Newman's Gauge, placed 4½ feet above the ground.*

1880.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		in.	in.			in.	in.	in.	in.	in.		
1							0·40	0·13	0·10			
2							**8·20**	0·10		0·01		
3						0·25	1·04	0·30	0·03	0·01		
4							0·26	0·16	0·20	0·01		
5						1·80	4·31	0·20	0·26	0·07		
6			0·02			2·06	0·33	0·40	0·17			
7						0·08	0·53	0·08	0·57			
8						0·01	0·24	0·04	0·11			
9						0·15	0·11	0·02	0·01			
10						0·01	0·03	0·53	2·89			
11							0·02	0·15	**3·92**			
12							0·43	0·04	0·34			
13							0·16	0·06	2·65			
14							0·01	0·08	1·52			
15							0·04	0·01	0·66			
16							0·03	0·22	2·49			
17		0·01				0·04	0·05	0·10	2·50			
18						0·02	0·03		0·19			
19							0·13	0·02	2·04	0·04		
20							0·03		0·19	0·11		
21						0·01	0·54	0·48		**0·91**		
22						0·10	0·02	**0·56**	1·00			
23						0·34	0·01	0·15	0·16			
24						**4·76**	0·44	0·04				
25						2·55	0·63					
26						1·37	0·04		0·78			
27						4·12	0·09	0·02	0·02			
28						1·42	0·02	0·08				
29						1·41	0·08	0·10				
30						0·98	0·02	0·01		0·02		
31							0·10					
Monthly Total...		0·01	0·02			21·48	18·37	4·08	**22·80**	1·18		
Number of rainy days...		1	1			19	**31**	26	23	8		

Total fall of rain in the year ... ... 67·94 inches.
Total number of rainy days in the year ... ... 1·09
The greatest daily fall of rain in the year (that of 2nd July) was ... ... 8·20 inches.
No rain fell in the months of January, April, May, November, and December, nor on any of the days left blank in the above table.

Rainfall, 1880.

TABLE XXXVIII.—*Total Fall of Rain (in inches) as measured by Osler's Gauge, placed 46 feet above the ground.*

1880.	MONTH.											
DATE.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.
			in.			in.	in.	in.	in.	in.		
1							0·33	0·10	0·07			
2							**7·57**	0·09				
3						0·21	0·96	0·25	0·02	0·01		
4							0·23	0·12	0·15			
5						1·72	4·01	0·17	0·23	0·05		
6			0·01			2·01	0·27	0·29	0·13			
7						0·05	0·48	0·04	0·45			
8						0·01	0·19	0·04	0·07			
9						0·14	0·08	0·01				
10						0·01	0·02	0·48	2·60			
11							0·01	0·11	**3·44**			
12							0·32	0·03	0·31			
13							0·13	0·03	2·48			
14							0·01	0·07	1·32			
15							0·03		0·57			
16							0·02	0·17	2·31			
17						0·04	0·05	0·09	2·33			
18						0·01	0·02		0·17			
19							0·11		1·94	0·02		
20							0·02		0·14	0·09		
21							0·45	0·46		**0·79**		
22						0·09	0·01	**0·50**	0·90			
23						0·28	0·01	0·12	0·15			
24						**4·50**	0·37	0·03				
25						2·30	0·58					
26						1·16	0·03		0·74			
27						3·75	0·07	0·01				
28						1·27	0·01	0·06				
29						1·24	0·07	0·09				
30						0·87	0·01			0·01		
31							0·06					
Monthly Total.			0·01			19·66	16·53	3·36	**20·52**	0·97		
Number of rainy days.			1			18	**31**	23	21	6		

Total fall of rain in the year ... ... 61·05 inches.
Total number of rainy days in the year 100
The greatest daily fall of rain in the year (that of 2nd July) was ... ... 7·57 inches.

No rain fell in the months of January, February, April, May, November and December, nor on any of the days left blank in the above table.

Extent of Cloudy Sky, 1881.

TABLE XXXIX.—*Means of Estimations made at 6, 10, 14, 16 and 22 hours daily, the whole Sky being reckoned as 8.*

1881. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
							MONTH.					
1	0·2	0·2	0·2	0·8	2·0	4·4	**8·0**	**8·0**	**8·0**	7·6		6·0
2	**4·2**	2·6	0·2	0·4		4·8	8·0	8·0	6·0	7·4	4·4	
3	3·6		1·4	1·0		3·8	7·4	8·0	7·2	**7·8**	4·4	
4			0·6	3·2		3·2	8·0	7·8	5·6	6·0	4·0	
5			0·2	1·2		5·4	8·0	7·4	5·8	3·6	**7·8**	
6				4·6		7·6	7·8	8·0	5·4	3·0	7·8	
7	1·0		2·0	0·8	2·6	7·4	7·2	8·0	3·2	1·0	5·4	
8				2·8	3·2	**8·0**	7·0	6·6	6·8	3·0	4·4	
9			0·4	5·8	3·2	8·0	8·0	6·8	6·8	1·4	0·4	
10	0·2			**6·8**	1·2	8·0	8·0	8·0	6·4	2·2	1·8	
11	0·2		0·4	3·8	3·6	8·0	8·0	8·0	8·0	2·0	4·4	
12	0·2		0·2	1·0	3·4	6·2	8·0	8·0	8·0	0·6	4·2	
13				0·2	**6·4**	4·8	7·8	7·8	8·0	0·6	3·4	
14	1·2	5·2		1·6	1·8	7·4	7·4	7·6	5·4	1·2	5·8	5·2
15		**7·6**	2·0	2·0	1·2	3·2	7·0	8·0	3·6		4·2	1·6
16	2·2	6·0			3·4	3·0	7·6	7·0	6·4		1·6	4·2
17	2·6	0·8	0·8		1·4	5·4	8·0	8·0	6·0		2·2	**6·6**
18			1·6	0·4	1·2	4·8	6·6	8·0	7·8		1·2	3·0
19	0·6			0·4	0·8	5·8	6·0	7·2	5·6	0·4		
20	3·0	0·2			1·2	3·6	6·4	6·8	6·4	0·2		3·6
21	1·6	0·4		0·2	1·8	2·6	**5·8**	6·8	3·4	1·0		0·8
22				0·4	1·2	**1·0**	7·8	7·0	7·0	2·0		
23	0·8				3·4	7·2	7·0	8·0	**3·0**	1·4		1·4
24	0·2		2·6	4·0	2·2	8·0	8·0	7·2	3·6	0·2		0·6
25	0·4	0·4	**3·4**	2·2	4·2	7·2	8·0	5·0	3·0	2·2		
26			0·6	5·6	3·4	7·6	7·0	**3·8**	8·0	0·6		0·6
27			0·6	2·4	1·6	5·4	6·4	7·8	7·8			1·0
28		0·6	0·2	0·4	1·2	7·6	7·0	6·6	6·8	0·2	0·4	0·8
29					3·2	8·0	8·0	6·2	6·4		0·4	1·6
30				0·2	3·0	8·0	7·6	4·0	6·4		1·4	0·2
31			1·4		3·8		7·8	5·6				
Monthly Mean.	0·7	0·9	**0·6**	1·7	2·1	5·8	**7·4**	7·1	6·1	1·8	2·3	1·2
Annual Variation.	−2·4	−2·2	−2·5	−1·4	−1·0	+2·7	+4·3	+4·0	+3·0	−1·3	−0·8	−1·9

For the days which have no entry 0·0 is to be understood.

Mean of the months from January to April, November and December ... ... 1·2

Mean of the months from May to October ... ... 5·0

Mean for the year ... ... 3·1

Rainfall, 1881.

TABLE XL.—*Total Fall of Rain (in inches) as measured by Newman's Gauge, placed 4½ feet above the ground.*

1881.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November	December
			in.		in.	in.	in.	in.	in.	in.	in.	
1						0·14	2·51	0·02	0·36	0·27		
2							2·99	0·64	0·08	1·64		
3							1·33	**11·30**	0·01	2·19		
4							3·80	1·32	0·31	0·07		
5						0·02	2·89	0·18	0·26			
6						0·38	2·96		0·26			
7							0·05	0·60	0·01			
8						0·35	0·01	0·30				
9						1·62	1·53	0·02	0·08			
10						**3·42**	**4·62**	0·58			0·03	
11						2·59	2·02	0·35	0·08			
12						0·16	1·02	0·49	0·58			
13						0·07	0·28	0·17	**0·90**			
14						0·05	0·19	0·04	0·07			
15						0·02	0·12	0·02	0·04		0·02	
16							0·07	0·14	0·16			
17						0·15	0·24	0·64	0·09			
18						0·04	0·10	0·26			0·04	
19						0·02	0·01	0·02	0·16			
20						0·02	0·01	0·16	0·04			
21							0·01	0·04	0·02			
22							0·93	0·14	0·12			
23						0·97	0·10	0·60				
24						1·48	0·08	0·39				
25			0·04		0·01	0·53	0·17	0·08				
26						0·66	0·45					
27						1·77	0·07		0·88			
28							0·08	0·03				
29						0·41	0·57	0·08	0·05			
30					0·20	0·42	0·14	0·33				
31					0·15		0·12	0·12				
Monthly Total			0·04		0·36	15·29	**29·47**	19·06	4·56	4·17	0·09	
Number of rainy days ...			1		3	22	31	28	21	4	3	

Total fall of rain in the year ... ... 73·04 inches.
Total number of rainy days in the year 113
The greatest daily fall of rain in the year (that of 3rd August) was ... ... 11·30 inches.
No rain fell in the months of January, February, April and December, nor on any of the days left blank in the above table.

Rainfall, 1881.

TABLE XLI.—*Total Fall of Rain (in inches) as measured by Osler's Gauge, placed 46 feet above the ground.*

1881.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November	December.
			in.		in.	in.	in.	in.	in.	in.	in.	
1						0·12	2·30	0·01	0·29	0·25		
2							2·74	0·55	0·07	1·56		
3							1·31	**10·63**		2·07		
4							3·57	1·22	0·31	0·05		
5						0·01	2·65	0·16	0·21			
6						0·31	2·80		0·25			
7							0·04	0·53	0·01			
8						0·29		0·25				
9						1·47	1·38	0·01	0·06			
10						**3·20**	**4·26**	0·44			0·02	
11						2·45	1·81	0·30	0·06			
12						0·13	0·85	0·42	0·51			
13						0·05	0·24	0·12	**0·85**			
14						0·03	0·14	0·03	0·06			
15						0·01	0·08	0·01	0·03			
16							0·04	0·12	0·14			
17						0·12	0·19	0·53	0·08			
18						0·03	0·06	0·21			0·03	
19						0·01		0·02	0·12			
20						0·01		0·12	0·03			
21								0·05	0·01			
22							0·84	0·11	0·09			
23						0·87	0·07	0·50				
24						1·29	0·04	0·39				
25			0·02			0·46	0·13	0·07				
26						0·58	0·41					
27						1·69	0·05		0·81			
28							0·06	0·01				
29						0·35	0·55	0·08	0·03			
30					0·16	0·38	0·11	0·27				
31					0·11		0·09	0·10				
Monthly Total			0·02		0·27	13·86	**26·81**	17·26	4·02	3·93	0·05	
Number of rainy days ...			1		2	22	27	**28**	20	4	0·02	

Total fall of rain in the year ... ... 66·22 inches.
Total number of rainy days in the year 106
The greatest daily fall of rain in the year (that of 3rd August) was ... ... 10·63 inches.
No rain fell on the months of January, February, April and December, nor on any of the days left blank in the above table.

Extent of Cloudy Sky, 1882.

TABLE XLII.—*Means of estimations made at 6, 10, 14, 16, and 22 hours daily, the whole Sky being reckoned as 8.*

1882.	MONTH.											
Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1		1·4		3·2	3·0	6·4	**8·0**	7·8	7·6	7·2	4·2	0·2
2	2·0			0·6		**8·0**	8·0	**8·0**	**8·0**	**8·0**	1·6	0·6
3	**5·8**		0·8	0·6	0·4	8·0	8·0	5·8	8·0	6·0		0·6
4	1·6				2·2	8·0	8·0	7·4	7·6	1·4		
5	0·8		0·6	0·4	2·2	7·0	8·0	6·6	7·6	0·8		
6	0·2				2·2	6·6	8·0	7·8	7·0	2·0		
7			2·6		1·4	5·6	8·0	7·8	8·0	5·2		
8	1·4		3·2	0·2	0·8	5·0	8·0	8·0	7·6	1·8		
9	2·6		2·8	0·6	2·2	5·2	6·6	7·8	7·4	3·2		
10	1·2				1·0	5·4	8·0	5·2	8·0	2·8		
11	3·6			0·8	1·4	8·0	8·0	7·0	8·0	2·8		
12		1·0		0·2	1·0	8·0	8·0	7·6	8·0	0·4	1·4	
13		0·2	0·4		2·8	7·8	8·0	7·0	6·6			
14	0·2	0·6	2·8		3·6	7·8	8·0	7·0	2·8	0·6		
15		0·4	0·6		1·2	8·0	7·2	7·2	4·2	5·6	3·0	0·4
16		**2·4**	**4·6**		3·0	6·4	8·0	6·4	7·0	4·0		1·8
17		0·4	0·6		1·6	6·8	8·0	5·4	4·8	5·4	0·2	
18	0·2	2·4	2·2		1·6	**2·4**	8·0	6·4	3·8	1·6	0·2	
19		0·4			2·8	4·0	8·0	6·2	3·4	0·4	0·6	
20			0·2		**5·6**	2·8	8·0	**4·0**	4·0	0·2	0·2	
21			0·4	0·8	3·2	5·4	8·0	7·6	**1·8**	1·6	1·6	2·2
22			4·0		1·4	4·4	8·0	5·6	5·6	1·8	0·6	2·6
23			4·2		1·0	5·4	8·0	5·6	7·6		6·0	
24				0·2	2·2	5·0	8·0	6·6	6·2	0·8	**7·4**	0·2
25					2·2	7·6	7·8	5·8	6·0	0·6	5·8	**7·4**
26					3·2	7·6	5·6	6·6	6·8		3·6	0·8
27					3·6	7·4	7·8	5·2	1·8		5·4	
28		0·6	0·2	2·6	5·6	8·0	6·2	6·2	3·6	2·8	6·4	0·4
29	1·2		1·0	**5·0**	4·2	7·4	**5·4**	5·4	4·8	4·0	2·2	
30	5·6		0·2	1·0	3·0	7·8	7·8	7·8	7·0	0·2	1·2	2·2
31	1·0		3·2		4·0		8·0	8·0				
Monthly Mean .	0·9	**0·3**	1·1	0·5	2·4	6·4	**7·7**	6·7	6·0	2·3	1·7	0·6
Annual Variation ...	—2·1	—2·7	—1·9	—2·5	—0·6	+3·4	+4·7	+3·7	+3·0	—0·7	—1·3	—2·4

For the days which have no entry 0·0 is to be understood.

Mean of the months from January to April, November and December... ... 0·8

Mean of the months from May to October ... ... 5·2

Mean for the year ... ... 3·0

Rainfall, 1882.

TABLE XLIII.—*Total Fall of Rain (in inches) as measured by Newman's Gauge, placed 4½ feet above the ground.*

1882. Date.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	
1				0·07			1·86	0·46	0·41			
2				0·01		4·22	1·86	0·05	1·14	0·10		
3						**10·18**	2·37	0·10	0·73	0·25		
4						3·13	1·18	0·40	0·68	0·77		
5						0·77	0·95	**0·50**	1·22			
6						0·15	1·04	0·25	1·58			
7						0·01	0·71	0·03	**2·73**			
8						0·65	3·67	0·02	0·24			
9							0·64		0·18			
10						0·14	0·68	0·10	0·78			
11						3·64	0·33	0·15	0·15			
12						0·79	2·08	0·03	0·05			
13						0·51	0·22	0·12				
14						0·52	0·06	0·14				
15						0·10	0·57	0·07				
16		0·04				0·19	0·19	0·08				
17						0·21	**5·14**					
18							0·12					
19						0·01	0·86					
20							0·78	0·05	0·02			
21							0·13	0·02				
22						0·18	0·20	0·02	0·03			
23			0·02			0·26	0·02		0·12			
24						0·02	0·01	0·17				
25						0·81	0·03					
26						0·05	0·11	0·08				
27						0·37	0·39		0·01		0·01	
28						0·29	0·34	0·17			0·02	
29						0·26			0·01			
30						0·08	0·03	0·20				
31					0·02		0·37	0·15				
Monthly Total...		0·04	0·02	0·08	0·02	**27·54**	26·94	3·36	10·08	1·12	0·03	
Number of rainy days... ...		1	1	2	1	25	**30**	23	17	3	2	

Total fall of rain in the year ... ... 69·23 inches.
Total number of rainy days in the year 105
The greatest daily fall of rain in the year (that of 3rd June) was ... ... 10·18 inches.
No rain fell in the months of January and December, nor on any of the days left blank in the above table.

Rainfall, 1882.

TABLE XLIV.—*Total Fall of Rain (in inches) as measured by Osler's Gauge, placed 46 feet above the ground.*

1882.	MONTH.											
DATE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		in.	in.	in.		in.	in.	in.	in.	in.	in.	
1				0·06			1·70	0·36	0·36			
2				0·01		2·92	1·73	0·04	1·03	0·08		
3						**9·09**	2·19	0·08	0·63	0·21		
4						2·87	0·95	0·27	0·58	0·70		
5						0·72	0·80	**0·40**	1·08			
6						0·13	0·83	0·18	1·57			
7						0·01	0·55	0·02	**2·58**			
8						0·59	3·20	0·01	0·18			
9							0·53		0·14			
10						0·11	0·58	0·10	0·67			
11						3·24	0·24	0·11	0·11			
12						0·54	1·77	0·02	0·03			
13						0·43	0·18	0·10				
14						0·45	0·04	0·10				
15						0·06	0·48	0·05				
16		0·02				0·18	0·13	0·07				
17						0·21	**4·53**					
18							0·08					
19							0·66					
20							0·68	0·03	0·01			
21							0·08	0·01				
22						0·12	0·14	0·02	0·02			
23			0·01			0·26	0·02		0·10			
24								0·16				
25						0·74	0·02					
26						0·02	0·09	0·07				
27						0·31	0·32					
28						0·26	0·31	0·16			0·01	
29						0·20						
30						0·06	0·03	0·16				
31							0·34	0·14				
Monthly Total.		0·02	0·01	0·07		**23·52**	23·20	2·66	9·09	0·99	0·01	
Number of rainy days ...		1	1	2		23	**29**	23	15	3	1	

Total fall of rain in the year ... ... 59·57 inches.
Total number of rainy days in the year 98
The greatest daily fall of rain in the year (that of 3rd June) was ... ... 9·09 inches.
No rain fell in the months of January, May and December, nor on any of the days left blank in the above table.

Maxima and Minima of different Meteorological Elements.

Tables in which are collected the individual observations in each month of the year, which showed the greatest and the least values of the following elements, viz., Height of Barometer, corrected for Temperature; Temperature of Air; Pressure of Vapour; and Additional Capacity of Air.

	Month.	Height of Barometer.			Temperature of Air.			Pressure of Vapour.			Additional Capacity.		
		Greatest.	Least.	Range.	Greatest.	Least.	Range.	Greatest.	Least.	Range.	Greatest.	Least.	Range.
		in.	in.	in.	°	°	°	in.	in.	in.	in.	in.	in.
Table XLV., 1879.	January... ...	30·044	29·820	0·224	87·5	67·5	20·0	0·764	0·351	0·413	0·812	0·074	0·738
	February ...	·080	·740	·340	84·2	65·4	18·8	·789	·349	·440	·723	·074	·649
	March	29·993	·711	·282	91·5	67·7	23·8	·874	·295	·579	1·018	·062	·956
	April	·920	·689	·231	88·1	74·9	13·2	·951	·507	·444	0·666	·093	·573
	May	·854	·294	·560	96·5	74·1	22·4	1·049	·667	·382	·870	·042	·828
	June	·838	·496	·342	87·5	76·4	11·1	1·006	·772	·234	·377	·047	·330
	July	·810	·526	·284	86·0	76·1	9·9	0·975	·771	·204	·361	·037	·324
	August	·796	·543	·253	84·0	74·7	9·3	·965	·768	·197	·253	·043	·214
	September ...	·980	·629	·351	83·9	74·1	9·8	·917	·712	·205	·352	·056	·296
	October	·980	·682	·298	91·7	71·4	20·3	·997	·384	·613	·955	·061	·894
	November ...	30·048	·716	·332	88·8	66·1	22·7	·860	·281	·579	·996	·060	·936
	December ...	·008	·767	·241	86·2	65·8	20·4	·748	·285	·463	·855	·031	·824
	Year ...	30·080	29·294	0·786	96·5	65·4	31·1	1·049	0·281	0·768	1·018	0·031	0·987
Table XLVI., 1880.	January... ...	30·089	29·712	0·377	87·4	64·5	22·9	0·777	0·262	0·515	1·032	0·043	0·969
	February ...	·062	·755	·307	89·8	60·4	29·4	·784	·272	·512	0·959	·074	·885
	March	·038	·679	·359	89·2	70·7	18·5	·935	·370	·565	·719	·073	·646
	April	29·910	·678	·232	91·9	77·1	14·8	·999	·632	·367	·792	·116	·676
	May	·878	·505	·373	90·1	80·1	10·0	·950	·764	·186	·532	·188	·344
	June	·786	·477	·309	90·0	73·8	16·2	1·017	·734	·283	·491	·044	·447
	July	·814	·519	·295	85·0	74·9	10·1	0·984	·777	·207	·296	·036	·260
	August	·894	·546	·348	84·4	75·9	8·5	·965	·749	·216	·348	·055	·293
	September ...	·975	·575	·400	84·0	73·3	10·7	·947	·719	·228	·370	·039	·331
	October	30·002	·681	·321	90·2	75·1	15·1	1·035	·651	·384	·768	·052	·716
	November ...	·054	·787	·267	90·2	72·2	18·0	0·894	·458	·436	·936	·076	·860
	December ...	·103	·858	·245	88·3	68·2	20·1	·845	·366	·479	·798	·093	·705
	Year...	30·103	29·477	0·626	91·9	60·4	31·5	1·035	0·262	0·773	1·012	0·036	0·976
Table XLVII., 1881.	January... ...	30·100	29·820	0·280	88·1	67·9	20·2	0·801	0·329	0·472	0·863	0·089	0·774
	February ...	·120	·815	·305	87·9	69·2	18·7	·929	·360	·569	·850	·097	·753
	March	·003	·780	·223	87·3	71·7	15·6	·858	·465	·393	·760	·071	·689
	April	29·967	·658	·309	90·8	75·5	15·3	·991	·553	·438	·726	·098	·628
	May	·890	·625	·265	91·2	79·1	12·1	1·009	·703	·306	·538	·102	·436
	June	·840	·602	·238	89·9	73·2	16·7	0·982	·724	·258	·513	·038	·475
	July	·838	·527	·311	85·9	76·1	9·8	·986	·735	·251	·297	·034	·263
	August	·849	·504	·345	84·8	75·2	9·6	·947	·789	·158	·341	·024	·317
	September ...	·900	·607	·293	84·7	75·1	9·6	·971	·716	·255	·368	·053	·315
	October	·990	·638	·352	91·0	75·0	16·0	1·014	·521	·493	·835	·037	·798
	November ...	30·035	·731	·304	92·0	67·1	24·9	0·913	·286	·627	1·001	·087	·914
	December ...	·053	·796	·257	88·9	68·0	20·9	·795	·370	·425	0·906	·069	·837
	Year ...	30·120	29·504	0·616	92·0	67·1	24·9	1·014	0·286	0·728	1·001	0·024	0·977
Table XLVIII., 1882.	January... ...	30·140	29·840	0·300	88·6	65·9	22·7	0·826	0·355	0·471	0·994	0·071	0·923
	February ...	·062	·791	·271	92·1	65·1	27·0	·847	·283	·564	1·123	·071	1·052
	March	·048	·678	·370	91·2	67·5	23·7	·982	·392	·590	0·827	·063	0·764
	April	29·892	·631	·261	89·6	75·8	13·8	·993	·610	·383	·643	·095	·548
	May	·931	·594	·337	89·3	77·9	11·4	·958	·673	·285	·542	·166	·376
	June	·830	·366	·464	88·9	74·5	14·4	1·047	·749	·298	·490	·019	·471
	July	·797	·466	·331	83·8	74·8	9·0	0·946	·764	·182	·268	·036	·232
	August	·860	·568	·292	84·8	76·0	8·8	·929	·721	·208	·355	·068	·287
	September ...	·909	·567	·342	85·0	74·0	11·0	·971	·773	·198	·357	·041	·316
	October	·936	·684	·252	90·7	72·2	18·5	1·000	·416	·584	·912	·050	·862
	November ...	30·014	·715	·299	88·0	69·8	18·2	0·867	·346	·521	·786	·056	·730
	December ...	·089	·766	·323	86·9	68·3	18·6	·827	·421	·406	·802	·065	·737
	Year ...	30·140	29·366	0·774	92·1	65·1	27·0	1·047	0·283	0·764	1·123	0·019	1·104

Temperature of the Ground, 1879 to 1882.

Showing, for each month, the Mean Temperature of the Ground, and its Annual Variation, at the respective depths of 1, 9, 20, 60 *and* 132 *inches below the surface.*

TABLE XLIX. — 1879.

DEPTH.	1 Inch.		9 Inches.		20 Inches.		60 Inches.		132 Inches.	
MONTH.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.
	°	°	°	°	°	°	°	°	°	°
January	77·2	− 3·4	76·9	− 3·4	79·3	− 2·6	82·1	− 0·8	82·5	− 0·1
February	77·3	− 3·3	77·0	− 3·3	79·2	− 2·7	**81·4**	− 1·5	82·1	− 0·5
March	80·7	+ 0·1	79·7	− 0·6	80·5	− 1·4	81·8	− 1·1	**81·9**	− 0·7
April	83·4	+ 2·8	82·6	+ 2·3	83·0	+ 1·1	82·8	− 0·1	82·0	− 0·6
May	**84·7**	+ 4·1	**84·1**	+ 3·8	**84·8**	+ 2·9	84·2	+ 1·3	82·6	0·0
June	83·6	+ 3·0	83·5	+ 3·2	84·8	+ 2·9	**84·7**	+ 1·8	83·0	+ 0·4
July	82·9	+ 2·3	82·8	+ 2·5	84·3	+ 2·4	84·6	+ 1·7	**83·6**	+ 1·0
August	80·1	− 0·5	80·8	+ 0·5	82·9	+ 1·0	83·9	+ 1·0	83·4	+ 0·8
September	81·2	+ 0·6	80·9	+ 0·6	82·5	+ 0·6	83·1	+ 0·2	82·9	+ 0·3
October	81·7	+ 1·1	81·1	+ 0·8	82·4	+ 0·5	82·8	− 0·1	82·6	0·0
November	78·5	− 2·1	78·4	− 1·9	81·0	− 0·9	82·5	− 0·4	82·3	− 0·3
December	**75·6**	− 5·0	**75·6**	− 4·7	**78·4**	− 3·5	81·5	− 1·4	81·9	− 0·7
Year	80·6		80·3		81·9		82·9		82·6	

TABLE L. — 1880.

1 Inch.		9 Inches.		20 Inches.		60 Inches.		132 Inches.	
Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.	Mean Temperature.	Excess over the yearly Mean.
°	°	°	°	°	°	°	°	°	°
75·6	− 6·0	75·2	− 5·7	77·6	− 4·9	80·5	− 2·4	81·4	− 1·0
75·4	− 6·2	**75·1**	− 5·8	**77·4**	− 5·1	**80·0**	− 2·9	**80·9**	− 1·5
82·3	+ 0·7	80·6	− 0·3	80·4	− 2·1	80·4	− 2·5	80·9	− 1·5
85·4	+ 3·8	83·8	+ 2·9	83·9	+ 1·4	82·5	− 0·4	81·2	− 1·2
86·8	+ 5·2	**85·3**	+ 4·4	85·4	+ 2·9	84·0	+ 1·1	82·1	− 0·3
85·2	+ 3·6	85·0	+ 4·1	**86·4**	+ 3·9	**85·3**	+ 2·4	83·2	+ 0·8
81·6	0·0	82·0	+ 1·1	84·2	+ 1·7	85·0	+ 2·1	**83·7**	+ 1·3
81·7	+ 0·1	80·5	− 0·4	83·4	+ 0·9	84·0	+ 1·1	83·6	+ 1·2
80·8	− 0·8	81·0	+ 0·1	82·9	+ 0·4	83·5	+ 0·6	83·4	+ 1·0
83·3	+ 1·7	82·3	+ 1·4	83·4	+ 0·9	83·4	+ 0·5	83·0	+ 0·6
82·0	+ 0·4	81·3	+ 0·4	83·0	+ 0·5	83·5	+ 0·6	82·8	+ 0·4
79·4	− 2·2	79·1	− 1·8	81·7	− 0·8	83·2	+ 0·3	82·7	+ 0·3
81·6		80·9		82·5		82·9		82·4	

TABLE LI. — 1881.

78·8	− 3·5	**78·2**	− 3·5	**80·5**	− 2·9	82·6	− 1·6	82·4	− 1·0
79·9	− 2·4	79·0	− 2·7	80·5	− 2·9	**82·3**	− 1·9	82·1	− 1·3
81·8	− 0·5	80·8	− 0·9	82·0	− 1·4	82·7	− 1·5	**82·0**	− 1·4
84·7	+ 2·4	83·5	+ 1·8	84·0	+ 0·6	83·7	− 0·5	82·5	− 0·9
87·6	+ 5·3	**86·2**	+ 4·5	86·5	+ 3·1	85·3	+ 1·1	83·3	− 0·1
85·4	+ 3·1	85·2	+ 3·5	**87·0**	+ 3·6	**86·6**	+ 2·4	84·2	+ 0·8
82·4	+ 0·1	82·9	+ 1·2	85·3	+ 1·9	86·2	+ 2·0	**84·7**	+ 1·3
82·0	− 0·3	82·1	+ 0·4	84·1	+ 0·7	85·1	+ 0·9	84·5	+ 1·1
82·0	− 0·3	81·9	+ 0·2	83·8	+ 0·4	84·5	+ 0·3	84·0	+ 0·6
82·7	+ 0·4	82·0	+ 0·3	83·7	+ 0·3	84·2	0·0	83·8	+ 0·4
81·2	− 1·1	80·5	− 1·2	83·0	− 0·4	84·0	− 0·2	83·6	+ 0·2
78·8	− 3·5	78·3	− 3·4	81·0	− 2·4	83·3	− 0·9	83·2	− 0·2
82·3		81·7		83·4		84·2		83·4	

TABLE LII. — 1882.

78·5	− 2·8	78·0	− 2·9	80·4	− 2·5	82·6	− 1·2	82·7	− 0·6
77·7	− 3·6	**77·2**	− 3·7	**79·8**	− 3·1	**82·1**	− 1·7	82·3	− 1·0
82·0	+ 0·7	80·5	− 0·4	81·2	− 1·7	82·1	− 1·7	**82·0**	− 1·3
84·4	+ 3·1	83·3	+ 2·4	84·1	+ 1·2	83·5	− 0·3	82·4	− 0·9
86·1	+ 4·8	**84·9**	+ 4·0	85·6	+ 2·7	85·1	+ 1·3	83·3	0·0
83·3	+ 2·0	83·7	+ 2·8	**85·8**	+ 2·9	**86·0**	+ 2·2	84·1	+ 0·8
80·7	− 0·6	81·5	+ 0·6	84·2	+ 1·3	85·4	+ 1·6	**84·5**	+ 1·2
82·1	+ 0·8	81·8	+ 0·9	83·7	+ 0·8	84·6	+ 0·8	84·4	+ 1·1
81·4	+ 0·1	81·3	+ 0·4	83·3	+ 0·4	84·1	+ 0·3	84·0	+ 0·7
82·4	+ 1·1	81·8	+ 0·9	83·7	+ 0·8	83·9	+ 0·1	83·7	+ 0·4
79·5	− 1·8	79·2	− 1·7	81·8	− 1·1	83·6	− 0·2	83·4	+ 0·1
78·1	− 3·2	78·0	− 2·9	80·7	− 2·2	83·0	− 0·8	83·0	− 0·3
81·3		80·9		82·9		83·8		83·3	

Five-day Means.

TABLE LIII.—BAROMETRIC PRESSURE, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	in.	in.	in.	in.		in.	in.	in.	in.
	29+	29+	29+	29+		29+	29+	29+	29+
1	·956	·830	·972	·931	38	·654	·698	·662	·578
2	·928	·876	·945	·963	39	·716	·637	**·632**	·636
3	·929	·908	·933	1·007	40	·725	·643	·661	·608
4	·888	·922	·959	**1·015**	41	·706	·725	·706	·618
5	·907	·969	·978	·954	42	·657	·743	·712	·703
6	·925	·980	·985	·926	43	·614	·695	·669	·647
7	**·964**	·939	·973	·946	44	·626	·627	·672	·676
8	·940	·899	**·993**	·921	45	·689	·767	·692	·717
9	·937	·872	·909	·875	46	·705	·771	·704	·757
10	·854	·885	·952	·923	47	·727	·793	·690	·778
11	·823	·944	·949	·927	48	·712	·832	·729	·766
12	·858	·927	·887	·927	49	·691	·782	·773	·765
13	·885	·916	·860	·933	50	·761	·744	·798	·711
14	·886	·884	·897	·887	51	·796	·801	·734	·666
15	·842	·822	·880	·922	52	·815	·704	·740	·827
16	·840	·795	·907	·856	53	·765	·773	·763	·831
17	·868	·837	·900	·807	54	·823	·823	·820	·818
18	·845	·800	·935	·816	55	·868	·856	·788	·764
19	·784	·760	·859	·797	56	·764	·867	·744	·815
20	·783	·758	·827	·809	57	·791	·844	·708	·803
21	·797	·786	·821	·777	58	·855	·791	·836	·770
22	·793	·812	·812	·737	59	·906	·781	·880	·810
23	·837	·810	·808	·749	60	·830	·896	·887	·828
24	·781	·795	·775	·789	61	·826	·923	·854	·793
25	·736	·751	·713	·787	62	·839	·893	·843	·845
26	·752	·815	·778	·840	63	·911	·945	·810	·857
27	·773	·770	·807	·790	64	·920	·949	·815	·919
28	·696	·744	·758	·737	65	·883	·891	·866	·935
29	**·502**	·745	·743	·736	66	·916	·881	·935	·827
30	·588	·691	·743	·722	67	·942	·904	·934	·839
31	·691	**·594**	·707	·602	68	·910	·944	·901	·908
32	·761	·683	·678	·555	69	·908	·966	·900	·899
33	·743	·669	·679	**·499**	70	·867	**1·019**	·899	·915
34	·658	·701	·713	·703	71	·920	·970	·950	·990
35	·594	·718	·752	·758	72	·899	·986	·909	·955
36	·602	·642	·710	·762	73	·904	·978	·927	·968
37	·651	·625	·656	·671					

TABLE LIV.—TEMPERATURE OF THE AIR, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	°	°	°	°		°	°	°	°
1	75·7	71·6	74·8	77·1	38	81·8	78·8	81·5	79·2
2	73·7	74·2	75·3	75·9	39	82·3	80·8	80·7	79·6
3	73·7	71·8	76·4	74·1	40	81·4	81·0	81·2	79·0
4	74·8	72·9	77·0	76·3	41	81·3	79·3	81·1	79·6
5	75·4	73·9	77·6	76·4	42	81·4	80·0	80·8	79·8
6	76·0	74·4	76·1	75·5	43	78·6	80·0	80·2	79·8
7	75·5	75·1	75·2	73·9	44	78·5	79·3	80·4	79·4
8	75·4	72·8	78·6	76·9	45	79·7	79·3	79·6	80·5
9	72·9	71·2	75·7	75·8	46	78·7	79·8	80·2	80·5
10	74·7	**70·8**	77·4	73·5	47	77·8	79·9	80·3	80·6
11	75·3	73·0	77·5	**72·7**	48	79·0	80·5	80·8	80·7
12	77·7	75·8	79·8	76·5	49	79·6	80·7	80·6	80·1
13	74·3	77·8	77·9	73·8	50	79·8	80·0	81·0	77·9
14	78·0	79·9	79·3	77·5	51	80·2	79·1	79·2	78·6
15	78·2	78·4	79·2	80·5	52	80·0	78·0	80·3	80·1
16	79·1	80·2	79·0	81·6	53	79·4	77·7	81·0	80·8
17	80·5	82·7	79·3	82·5	54	78·3	79·5	79·9	80·0
18	81·4	82·9	80·0	82·0	55	79·0	80·0	80·2	81·0
19	81·9	83·8	80·4	82·6	56	79·6	81·1	80·5	79·2
20	80·8	82·3	83·2	81·6	57	80·6	83·5	79·8	81·9
21	81·1	83·4	81·4	81·3	58	80·6	81·3	80·9	79·9
22	80·6	83·7	82·0	82·8	59	80·8	80·6	80·0	80·8
23	82·0	82·6	82·4	80·8	60	79·4	80·0	81·2	80·3
24	82·6	83·7	83·8	82·7	61	77·9	81·7	80·5	77·6
25	83·4	84·2	83·5	83·0	62	77·4	80·0	79·8	77·1
26	83·4	83·6	85·2	83·0	63	77·4	81·4	79·5	77·5
27	**83·6**	84·2	85·1	83·1	64	76·4	79·2	81·3	76·8
28	83·6	84·7	85·3	83·2	65	76·2	77·7	77·7	77·4
29	82·6	85·1	85·6	84·0	66	74·6	79·7	75·5	75·7
30	80·8	85·1	**85·8**	**84·8**	67	73·5	79·4	76·4	77·7
31	82·9	85·3	85·8	80·9	68	73·0	79·0	76·9	75·6
32	83·6	84·3	82·9	82·1	69	74·4	77·4	75·0	76·5
33	83·1	**85·4**	81·7	81·1	70	73·7	75·1	78·0	73·9
34	81·0	85·1	84·3	82·7	71	73·3	75·7	76·8	76·4
35	81·5	82·5	83·1	83·0	72	72·7	77·1	**74·5**	75·9
36	80·4	78·4	82·0	81·6	73	**72·0**	76·6	76·0	75·2
37	80·8	79·1	79·9	78·9					

Five-day Means.

TABLE LV.—PRESSURE OF VAPOUR, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	in.	in.	in.	in.		in.	in.	in.	in.
1	0·580	0·501	0·598	0·593	38	0·905	0·861	0·927	0·890
2	·603	·619	·581	·647	39	·897	·872	·900	·876
3	·638	·626	·603	·580	40	·863	·869	·889	·872
4	·555	·628	·568	·600	41	·867	·845	·881	·865
5	·553	·533	·598	·619	42	·896	·842	·886	·851
6	·560	·505	**·526**	·617	43	·862	·842	·873	·838
7	·571	·596	·596	·582	44	·868	·856	·889	·851
8	·576	·500	·598	·693	45	·885	·829	·861	·865
9	·549	·488	·588	·668	46	·862	·814	·865	·840
10	·604	**·478**	·724	·544	47	·848	·813	·870	·818
11	·620	·583	·705	**·489**	48	·859	·809	·869	·817
12	·673	·578	·810	·621	49	·855	·805	·855	·859
13	·543	·723	·680	·556	50	·824	·827	·842	·866
14	·696	·672	·675	·736	51	·815	·841	·825	·864
15	·727	·773	·726	·767	52	·802	·863	·876	·831
16	·565	·846	·703	·739	53	·832	·839	·859	·835
17	·775	·835	·696	·845	54	·779	·811	·819	·881
18	·736	·803	·735	·704	55	·846	·837	·890	·908
19	·766	·792	·768	·819	56	·899	·907	·909	·823
20	·759	·833	·773	·782	57	·870	·913	·871	·884
21	·796	·840	·805	·788	58	·826	·803	·834	·865
22	·769	·904	·851	·797	59	·782	·889	·815	·821
23	·776	·783	·855	·758	60	·703	·826	·762	·766
24	·871	·890	·907	·871	61	·627	·843	·727	·652
25	·891	·856	·886	·774	62	·773	·687	·654	·703
26	·860	·822	**·932**	·816	63	·609	·696	·778	·685
27	·902	·843	·917	·844	64	·612	·716	·762	·633
28	·914	·863	·892	·859	65	·612	·699	·565	·665
29	·910	·860	·889	·847	66	·569	·772	·543	·560
30	·925	·885	·900	·889	67	**·486**	·708	·607	·783
31	**·950**	·913	·921	·884	68	·571	·716	·580	·633
32	·916	**·928**	·873	**·954**	69	·513	·682	·581	·643
33	·888	·889	·900	·923	70	·523	·650	·633	·651
34	·885	·891	·906	·919	71	·567	·629	·591	·647
35	·920	·873	·893	·879	72	·561	·579	·629	·638
36	·908	·860	·920	·887	73	·583	·605	·656	·604
37	·904	·881	·897	·875					

TABLE LVI.—ADDITIONAL CAPACITY OF THE AIR, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	in.	in.	in.	in.		in.	in.	in.	in.
1	0·315	0·280	0·271	0·344	38	0·181	0·124	0·151	0·107
2	·231	·231	·302	·254	39	·207	·181	·146	·135
3	·198	·159	·313	·270	40	·211	·191	·178	·121
4	·312	·187	·368	·316	41	·204	·158	·185	·145
5	·338	·313	·354	·297	42	·177	·182	·166	·168
6	·343	·355	·381	·271	43	·117	·183	·159	·181
7	·316	·279	·285	·264	44	·115	·145	·150	·153
8	·311	·310	·389	·237	45	·130	·172	·152	·177
9	·267	·283	·306	·229	46	·119	·205	·167	·200
10	·260	·282	·219	·287	47	**·105**	·209	·165	·228
11	·259	·233	·241	·321	48	·133	·231	·183	·231
12	·279	·323	·209	·303	49	·155	·245	·189	·170
13	·312	·234	·280	·281	50	·192	·196	·218	**·091**
14	·267	·350	·330	·213	51	·215	·157	·174	·113
15	·242	·201	·275	·278	52	·224	**·098**	·158	·199
16	**·438**	·190	·294	·346	53	·174	·112	·198	·218
17	·270	·284	·306	·270	54	·189	·196	·204	·145
18	·343	·330	·292	**·399**	55	·148	·188	·143	·151
19	·326	·374	·273	·299	56	·112	·157	·135	·176
20	·296	·273	·368	·301	57	·176	·236	·148	·207
21	·270	·306	·268	·288	58	·219	·269	·226	·157
22	·279	·253	·245	·331	59	·275	·160	·216	·236
23	·323	·333	·256	·297	60	·308	·198	·309	·275
24	·246	·266	·255	·250	61	·333	·242	·320	·302
25	·254	·321	·268	·358	62	·170	·345	·373	·231
26	·287	·333	·279	·314	63	·338	**·382**	·233	·264
27	·250	·331	·294	·292	64	·305	·289	·312	·296
28	·237	·331	·327	·278	65	·298	·255	**·393**	·280
29	·215	·350	·342	·321	66	·294	·244	·348	·332
30	·128	·325	·336	·310	67	·348	·301	·311	·167
31	·174	·304	·317	·176	68	·248	·279	·354	·258
32	·236	·251	·260	·146	69	·344	·262	·293	·277
33	·247	·330	·186	·141	70	·314	·224	·334	·189
34	·177	·318	·271	·199	71	·261	·266	·338	·270
35	·155	·243	·241	·243	72	·250	·359	·231	·262
36	·128	·114	·175	·195	73	·207	·316	·248	·277
37	·149	·115	**·124**	·115					

Five-day Sums.

TABLE LVII.—*Rain-fall,* 1879 *to* 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	In.	In.	In.	In.		In.	In.	In.	In.
1	0·00	0·00	0·00	0·00	38	0·18	5·52	7·44	7·01
2	0·00	0·00	0·00	0·00	39	0·32	0·65	8·13	3·37
3	0·00	0·00	0·00	0·00	40	0·58	0·28	0·54	6·88
4	0·00	0·00	0·00	0·00	41	0·75	1·04	1·13	1·14
5	0·00	0·00	0·00	0·00	42	0·48	0·86	1·34	0·87
6	0·00	0·00	0·00	0·00	43	**10·67**	0·65	**12·22**	1·01
7	0·00	0·00	0·00	0·00	44	5·95	0·88	2·40	1·20
8	0·00	0·00	0·00	0·00	45	1·33	0·80	1·61	0·40
9	0·00	0·00	0·00	0·00	46	3·70	0·41	1·10	0·29
10	0·00	0·01	0·00	0·04	47	3·76	1·21	0·96	0·09
11	0·00	0·00	0·00	0·00	48	2·98	0·14	0·50	0·42
12	0·00	0·00	0·00	0·00	49	1·62	0·21	0·97	1·90
13	0·00	0·02	0·00	0·00	50	0·26	1·23	0·85	6·94
14	0·00	0·00	0·00	0·00	51	0·14	7·27	0·74	1·40
15	0·00	0·00	0·00	0·00	52	0·48	9·82	1·26	0·00
16	0·00	0·00	0·00	0·00	53	2·29	3·42	0·34	0·05
17	0·03	0·00	0·04	0·02	54	0·99	0·96	0·88	0·13
18	0·00	0·00	0·00	0·00	55	1·14	0·01	1·96	0·11
19	0·00	0·00	0·00	0·08	56	0·31	0·09	2·26	1·02
20	0·00	0·00	0·00	0·00	57	0·00	0·00	0·00	0·00
21	0·00	0·00	0·00	0·00	58	0·00	0·00	0·00	0·00
22	0·00	0·00	0·00	0·00	59	0·00	1·06	0·00	0·00
23	0·00	0·00	0·00	0·00	60	0·00	0·00	0·00	0·00
24	0·00	0·00	0·00	0·00	61	0·00	0·02	0·00	0·00
25	0·00	0·00	0·00	0·00	62	0·00	0·00	0·00	0·00
26	0·00	0·00	0·00	0·00	63	0·00	0·00	0·03	0·00
27	0·00	0·00	0·00	0·00	64	0·00	0·00	0·02	0·00
28	0·00	0·00	0·00	0·00	65	0·00	0·00	0·04	0·00
29	1·13	0·00	0·01	0·00	66	0·00	0·00	0·00	0·00
30	4·10	0·00	0·20	0·00	67	0·00	0·00	0·00	0·03
31	0·24	0·25	0·29	**17·55**	68	0·00	0·00	0·00	0·00
32	0·27	4·10	2·37	1·58	69	0·00	0·00	0·00	0·00
33	1·79	0·01	6·29	5·60	70	0·00	0·00	0·00	0·00
34	5·56	0·06	0·23	0·51	71	0·00	0·00	0·00	0·00
35	4·03	5·21	2·47	0·46	72	0·00	0·00	0·00	0·00
36	4·51	10·87	3·37	1·78	73	0·00	0·00	0·00	0·00
37	1·81	**10·88**	11·05	7·35					

Five-day Means.

TABLE LVIII.—NORTH OR SOUTH COMPONENT OF WIND, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	Miles.	Miles.	Miles.	Miles.		Miles.	Miles.	Miles.	Miles.
1	6·0 N	9·2 N	9·0 N	8·4 N	38	6·0 S	1·9 S	6·9 S	10·5 S
2	6·0 N	6·0 N	9·8 N	6·0 N	39	3·9 S	4·0 S	11·0 S	8·6 S
3	4·2 N	6·9 N	5·2 N	9·0 N	40	2·5 S	6·9 S	8·8 S	7·9 S
4	9·4 N	7·3 N	7·1 N	6·8 N	41	4·1 N	0·4 S	7·2 S	6·3 S
5	8·4 N	11·7 N	5·8 N	5·6 N	42	3·3 N	5·6 S	7·3 S	2·2 S
6	10·6 N	6·3 N	5·8 N	9·5 N	43	0·9 S	5·7 S	2·9 S	0·9 S
7	7·6 N	10·1 N	7·6 N	10·5 N	44	3·4 S	4·5 S	5·8 S	7·9 S
8	8·7 N	**12·5** N	5·1 N	2·0 N	45	6·8 S	3·5 S	4·3 S	1·5 S
9	7·0 N	7·4 N	7·2 N	8·4 N	46	5·2 S	1·4 S	1·5 S	1·4 S
10	3·2 N	8·6 N	5·4 N	10·5 N	47	2·8 S	1·9 S	3·1 S	1·5 N
11	3·4 N	7·4 N	6·9 N	9·2 N	48	4·7 S	2·1 N	0·7 S	0·2 S
12	9·7 N	9·3 N	2·6 N	6·8 N	49	2·3 N	3·8 N	4·4 S	0·1 N
13	10·5 N	2·1 N	5·3 N	6·7 N	50	1·5 S	1·6 S	1·9 S	0·2 S
14	10·1 N	8·8 N	**11·1** N	4·2 N	51	1·8 S	5·9 N	0·0	1·3 S
15	9·9 N	1·4 N	10·9 N	3·9 N	52	1·4 N	0·3 S	6·8 S	0·0
16	10·6 N	3·3 S	5·6 N	8·6 N	53	5·5 N	**8·9** S	4·6 S	4·7 N
17	4·8 N	2·0 N	3·1 N	0·3 N	54	5·4 N	4·5 N	0·0	3·7 N
18	**13·6** N	6·2 N	1·1 S	**12·6** N	55	3·1 N	9·6 N	4·9 N	2·6 N
19	6·2 N	7·3 N	9·9 N	5·0 N	56	9·2 S	1·4 N	4·0 N	1·4 S
20	5·6 N	1·5 N	11·1 N	8·9 N	57	0·9 N	4·2 N	8·2 N	5·0 N
21	7·6 N	9·1 N	8·3 N	2·8 N	58	7·1 N	8·0 N	7·3 N	0·1 N
22	2·1 N	1·7 S	5·0 N	7·6 N	59	6·6 N	4·2 S	5·3 N	7·4 N
23	5·5 N	3·3 N	5·0 N	3·0 N	60	7·4 N	6·5 S	4·7 N	4·2 N
24	1·1 N	2·3 N	3·0 N	0·9 S	61	7·9 N	5·7 N	7·2 N	6·6 N
25	1·6 N	1·1 S	3·7 N	0·6 S	62	2·3 N	8·0 N	4·8 N	4·3 N
26	8·2 N	6·8 N	12·4 S	3·0 N	63	7·5 N	8·2 N	2·0 N	5·7 N
27	8·8 N	5·7 N	3·3 S	3·8 N	64	6·4 N	4·2 N	4·1 N	6·3 N
28	2·8 N	1·3 N	1·1 S	6·4 N	65	7·5 N	5·3 N	7·9 N	6·3 N
29	7·3 S	2·5 N	7·8 N	3·8 N	66	9·9 N	7·1 N	5·4 N	9·6 N
30	6·4 S	5·8 N	**13·3** S	5·4 N	67	8·6 N	7·4 N	5·1 N	5·4 N
31	9·0 S	0·1 N	2·8 S	**12·5** S	68	5·0 N	7·8 N	5·8 N	5·4 N
32	4·1 S	4·6 S	6·2 N	6·1 S	69	8·2 N	4·2 N	5·1 N	5·1 N
33	7·5 N	3·6 S	0·9 S	7·9 S	70	7·5 N	7·8 N	6·8 N	8·4 N
34	7·2 S	0·5 S	8·1 S	3·9 S	71	7·3 N	7·5 N	7·4 N	5·1 N
35	**15·6** S	1·7 N	7·7 S	7·5 S	72	7·8 N	7·1 N	3·7 N	2·5 N
36	3·9 S	5·3 S	5·5 S	1·4 S	73	9·8 N	6·4 N	6·5 N	4·2 N
37	8·1 S	6·6 S	2·4 S	2·7 S					

TABLE LIX.—EAST OR WEST COMPONENT OF WIND, 1879 TO 1882.

Number of Five-day Period.	1879.	1880.	1881.	1882.	Number of Five-day Period.	1879.	1880.	1881.	1882.
	Miles.	Miles.	Miles.	Miles.		Miles.	Miles.	Miles.	Miles.
1	2·3 E	0·1 E	1·0 W	0·4 W	38	15·6 W	12·3 W	15·7 W	20·0 W
2	2·1 W	0·4 E	1·8 W	1·3 W	39	16·3 W	**24·2** W	**23·6** W	23·1 W
3	1·4 W	1·8 W	1·0 E	1·1 W	40	9·6 W	19·2 W	19·7 W	**23·5** W
4	1·9 W	2·1 W	1·7 E	1·0 E	41	4·1 W	13·4 W	20·0 W	20·4 W
5	0·9 E	0·7 E	0·4 W	0·8 E	42	3·7 W	19·6 W	15·9 W	15·4 W
6	1·9 W	**3·3** E	0·3 W	2·0 W	43	16·1 W	15·9 W	21·8 W	12·8 W
7	2·3 W	2·5 W	1·4 W	3·0 W	44	20·4 W	15·3 W	18·1 W	18·2 W
8	3·4 W	3·2 W	0·8 E	0·7 W	45	19·3 W	12·8 W	18·1 W	11·4 W
9	3·0 W	2·0 W	2·5 W	2·9 W	46	19·1 W	16·8 W	17·7 W	17·5 W
10	2·8 W	3·0 W	3·4 W	3·3 W	47	9·9 W	13·4 W	14·7 W	10·2 W
11	1·7 W	3·4 W	3·2 W	2·3 W	48	10·8 W	9·0 W	6·1 W	8·2 W
12	5·8 W	2·4 W	2·6 W	1·7 W	49	15·5 W	6·3 W	11·8 W	2·3 W
13	5·6 W	2·0 W	4·3 W	3·9 W	50	12·6 W	14·9 W	11·6 W	8·4 W
14	5·4 W	3·8 W	5·3 W	4·0 W	51	10·8 W	9·0 W	4·2 W	14·7 W
15	6·4 W	4·8 W	5·6 W	4·0 W	52	9·3 W	11·8 W	8·9 W	5·2 W
16	5·1 W	4·6 W	4·3 W	4·3 W	53	6·9 W	2·4 W	10·5 W	2·0 W
17	4·1 W	5·9 W	6·5 W	4·1 W	54	6·2 W	7·6 W	3·4 W	2·3 W
18	7·5 W	6·3 W	3·0 W	5·3 W	55	5·6 W	7·6 W	3·4 W	3·9 W
19	5·6 W	5·7 W	8·2 W	5·8 W	56	0·2 E	1·1 E	2·1 W	0·8 W
20	7·0 W	5·8 W	5·8 W	6·9 W	57	3·0 W	2·1 W	5·0 W	2·1 W
21	7·6 W	6·6 W	6·4 W	4·7 W	58	1·0 W	1·2 W	1·6 W	1·6 W
22	6·2 W	6·3 W	6·4 W	6·8 W	59	0·8 W	1·3 E	0·1 W	2·1 W
23	7·4 W	6·7 W	8·0 W	6·5 W	60	0·5 E	0·2 W	0·6 E	1·5 E
24	5·9 W	6·6 W	6·2 W	5·6 W	61	0·2 W	1·3 W	1·2 E	0·1 E
25	6·2 W	7·1 W	5·5 W	5·6 W	62	2·0 W	2·5 E	**8·4** E	1·1 W
26	7·6 W	8·4 W	5·8 W	8·0 W	63	3·1 E	1·9 E	3·3 E	0·5 W
27	8·8 W	9·3 W	6·0 W	8·5 W	64	2·3 E	2·0 E	0·6 E	2·1 E
28	8·2 W	8·3 W	6·9 W	9·9 W	65	0·8 E	0·1 E	0·9 E	0·1 W
29	**8·7** E	9·1 W	10·4 W	8·6 W	66	1·8 W	2·9 E	3·9 E	**3·5** E
30	0·4 E	9·5 W	1·8 W	8·2 W	67	5·2 E	0·2 E	2·9 E	0·9 W
31	8·4 W	6·1 W	13·0 W	2·9 W	68	2·0 E	1·0 E	4·2 E	0·5 W
32	9·3 W	9·8 W	10·9 W	6·2 W	69	2·2 E	0·6 E	2·4 E	2·4 E
33	10·6 W	13·8 W	8·5 W	18·5 W	70	5·2 E	1·7 W	3·1 E	2·4 W
34	5·7 W	16·8 W	14·1 W	17·3 W	71	1·3 E	0·9 E	1·4 E	1·0 E
35	0·2 W	9·5 W	5·9 W	12·8 W	72	0·5 E	2·4 E	0·9 E	1·7 E
36	**24·8** W	16·5 W	5·4 W	14·7 W	73	0·1 E	0·6 E	0·7 E	1·6 E
37	19·6 W	16·0 W	7·2 W	9·9 W					

Meteorological Elements, 1876 to 1880.

TABLE LX.—*Annual and Lustral Means.*

Year.	Barometric Pressure.	Temperature of Air.	Pressure of Vapour.	Additional Capacity.	Rainfall.*	Wind.	
						North Component.	East Component.
	In.	o	In.	In.	In.	Miles.	Miles.
1876	29·816	79·3	0·751	0·258	50·04	2·0 N	7·0 W
1877	29·846	80·3	0·788	0·257	69·89	1·8 N	5·3 W
1878	29·800	80·1	0·795	0·242	111·93	2·0 N	4·8 W
1879	29·801	78·6	0·748	0·240	61·40	3·2 N	5·4 W
1880	29·818	79·5	0·767	0·250	67·94	2·9 N	6·0 W
Mean	29·816	79·6	0·770	0·249	72·24	2·4 N	5·7 W

* Sums, *not* means.

Rainfall, 1879 to 1882.

TABLE LXI.—*Comparison of the Rainfall measured at different heights above the ground in each month.*

Month.	1879.			1880.			1881.			1882.		
	Newman's gauge.	F. Chambers's gauge.	Osler's gauge.	Newman's gauge.	F. Chambers's gauge.	Osler's gauge.	Newman's gauge.	F. Chambers's gauge.	Osler's gauge.	Newman's gauge.	F. Chambers's gauge.	Osler's gauge.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
January	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	0·01	0·00	0·00	...	...	...	0·04	0·03	0·02
March	0·03	0·02	0·02	0·02	0·01	0·01	0·04	0·02	0·02	0·02	0·01	0·01
April	...	...	...	...	...	...	...	...	...	0·08	0·07	0·07
May	5·23	4·67	4·33	...	...	...	0·36	0·32	0·27	0·02	0·01	0·00
June	16·56	16·06	14·89	21·48	20·80	19·66	15·29	14·07	13·86	27·54	24·99	23·52
July	11·21	10·30	9·84	18·37	17·57	16·53	29·47	28·25	26·81	26·94	25·61	23·20
August	22·36	21·40	19·14	4·08	3·79	3·36	19·06	18·63	17·26	3·36	3·13	2·66
September ...	5·61	5·36	4·86	22·80	21·84	20·52	4·56	4·37	4·02	10·08	9·80	9·09
October	0·40	0·35	0·33	1·18	0·98	0·97	4·17	4·06	3·93	1·12	1·08	0·99
November ...	...	...	...	...	...	...	0·09	0·04	0·05	0·03	0·01	0·01
December	...	...	...	...	...	...	...	...	...	...	...	...
Total for the year	61·40	58·16	53·41	67·94	64·99	61·05	73·04	69·76	66·22	69·23	64·74	59·57

For the months which have no entry 0·00 is to be understood.
The heights above the ground of the several gauges are—of Newman's 4½ feet, of F. Chambers's 28 feet, and of Osler's 46 feet.

TABLES OF RESULTS

OF

ABSOLUTE MAGNETICAL OBSERVATIONS,

1879 to 1882.

133497

B 825—1

Absolute Magnetical Observations.—Table I.

Observations of Vibration and Deflection, taken with the Kew Unifilar Magnetometer (No. 23, by Elliott Brothers), for the determination of Absolute Horizontal Force.

1879.

1879. Date.	Civil Time. Mean.	Magnet N. 23 a. Time of one Vibration b.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 c by N. 23 a at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance 0·8 foot ($X_{0\cdot8}$)	1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8} - X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5 A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
JAN. 2	12 2	2·7956	0·77	83·6	+1·3	14·01	78·9	18 8 2	9 12 22	83·5	13·92	79·5	C.	·65901	8·1035	8·1038	−·0003	8·1036		
„ „	14 46	2·7959	0·70	86·0	„	13·81	80·3	18 8 5	9 12 24	85·9	13·84	79·9	C.	·65930	8·1023	8·1025	−·0002	8·1024		
„ 8	12 6	2·7954	0·79	82·4	−0·1	14·87	78·9	18 7 47	9 12 12	82·8	14·62	79·2	P.	·65872	8·1044	8·1049	−·0005	8·1046		
„ „	14 48	2·7958	0·79	83·1	„	14·12	80·3	18 8 2	9 12 20	83·2	14·28	80·0	P.	·65892	8·1023	8·1029	−·0006	8·1026		
„ 15	12 18	2·7960	0·78	85·1	−0·9	14·61	80·7	18 6 29	9 11 35	85·1	14·30	84·4	C.	·65878	8·1072	8·1077	−·0005	8·1074	8·1044	3·7368
„ „	14 52	2·7963	0·75	83·6	„	11·55	101·5	18 7 5	9 11 48	83·9	12·67	95·6	C.	·65867	8·1042	8·1053	−·0011	8·1047		
„ 22	12 8	2·7958	0·84	83·8	−1·8	14·07	83·1	18 6 40	9 11 37	84·0	13·93	83·9	P.	·65854	8·1068	8·1076	−·0008	8·1072		
„ „	14 52	2·7962	0·83	86·1	„	13·37	87·0	18 7 2	9 11 50	85·0	13·61	85·6	P.	·65882	8·1055	8·1061	−·0006	8·1058		
„ 29	11 46	2·7957	0·89	83·4	+0·9	13·31	89·0	18 7 26	9 12 8	84·1	13·38	89·2	V.	·65889	8·1042	8·1040	+·0002	8·1041		
„ „	14 31	2·7959	0·86	82·5	„	13·18	88·7	18 7 49	9 12 16	83·6	13·34	89·2	V.	·65892	8·1020	8·1021	−·0001	8·1020		
FEB. 5	12 22	2·7956	0·88	85·5	+0·4	14·74	80·1	18 6 57	9 11 50	84·8	14·56	80·4	P.	·65884	8·1074	8·1077	−·0003	8·1075		
„ „	14 52	2·7956	0·92	83·6	„	14·28	81·2	18 7 7	9 11 55	84·8	14·36	81·0	P.	·65882	8·1051	8·1053	−·0002	8·1052		
„ 12	12 1	2·7941	0·98	79·5	+8·1	15·80	76·2	18 6 58	9 11 57	80·4	15·72	76·4	V.	·65857	8·1111	8·1105	+·0006	8·1108		
„ „	14 36	2·7952	0·98	80·8	„	15·07	78·8	18 7 25	9 12 12	80·7	15·41	77·6	V.	·65867	8·1072	8·1064	+·0008	8·1068		
„ 18	13 1	2·7953	0·92	85·2	−1·2	14·52	80·1	18 6 42	9 11 45	84·9	14·37	80·8	P.	·65884	8·1085	8·1085	·0000	8·1085	8·1066	3·7378
„ „	15 20	2·7957	0·93	85·0	„	13·90	81·4	18 7 12	9 12 2	84·8	14·12	81·4	P.	·65902	8·1055	8·1053	+·0002	8·1054		
„ 26	11 54	2·7959	0·79	83·7	−2·2	14·50	80·9	18 6 42	9 11 47	83·9	14·39	81·6	V.	·65857	8·1066	8·1062	+·0004	8·1064		
„ „	14 33	2·7966	0·73	82·8	„	13·92	82·7	18 6 57	9 11 59	84·5	14·13	82·2	V.	·65855	8·1023	8·1016	+·0007	8·1019		
MARCH 5	12 20	2·7953	0·99	81·4	+2·3	15·28	76·1	18 7 7	9 11 57	81·4	15·14	76·5	P.	·65845	8·1072	8·1072	·0000	8·1072		
„ „	14 51	2·7956	0·95	82·8	„	14·64	78·1	18 7 22	9 12 2	81·9	14·83	77·2	P.	·65864	8·1062	8·1066	−·0004	8·1064		
„ 12	12 46	2·7953	0·73	85·7	−3·9	14·73	82·7	18 5 47	9 11 12	85·0	14·64	83·1	V.	·65860	8·1122	8·1130	−·0008	8·1126		
„ „	14 39	2·7964	0·68	85·6	„	14·08	83·0	18 5 50	9 11 16	85·8	14·25	83·0	V.	·65854	8·1081	8·1085	−·0004	8·1083	8·1090	3·7389
„ 19	12 10	2·7955	0·84	85·1	+1·4	14·84	80·1	18 5 47	9 11 10	84·7	14·68	81·4	P.	·65854	8·1117	8·1126	−·0009	8·1121		
„ „	14 49	2·7958	0·84	85·6	„	14·00	83·0	18 6 17	9 11 27	84·6	14·21	82·6	P.	·65870	8·1094	8·1102	−·0008	8·1098		
„ 26	12 11	2·7968	0·78	88·3	−1·7	14·06	84·8	18 4 53	9 10 48	88·3	13·94	85·0	V.	·65842	8·1105	8·1109	−·0004	8·1107		
„ „	14 49	2·7978	0·80	86·3	„	13·44	85·2	18 5 30	9 11 9	87·1	13·72	85·0	V.	·65829	8·1046	8·1046	·0000	8·1046		

1879. Date.	Civil Time. Mean.	Magnet N. 23 a. Time of one Vibration b.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 c by N. 23 a at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. F. H. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance 0·8 foot ($X_{0\cdot8}$)	1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8}-X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
April 2	12 24	2·7967	0·81	88·0	− 2·0	14·12	85·0	18 4 15	9 10 27	87·2	13·91	85·4	P.	·65810	8·1137	8·1143	− ·0006	8·1140		
„ „	14 50	2·7972	0·84	88·3	„	13·46	86·4	18 4 30	9 10 37	87·7	13·62	86·1	P.	·65825	8·1111	8·1113	− ·0002	8·1112		
„ 9	12 2	2·7955	0·86	86·3	− 1·4	14·55	83·9	18 4 17	9 10 31	87·0	14·61	84·1	V.	·65839	8·1158	8·1160	− ·0002	8·1159		
„ „	14 37	2·7966	0·82	86·8	„	14·22	83·9	18 4 34	9 10 44	88·2	14·37	83·9	V.	·65840	8·1111	8·1107	+ ·0004	8·1109		
„ 16	12 9	2·7963	0·88	86·1	− 0·9	14·01	84·0	18 5 2	9 10 55	86·9	13·86	84·3	P.	·65832	8·1107	8·1107	·0000	8·1107	8·1112	3·7399
„ „	14 51	2·7967	0·84	87·0	„	13·41	85·5	18 5 17	9 11 2	87·0	13·56	85·1	P.	·65846	8·1092	8·1094	− ·0002	8·1093		
„ 23	12 11	2·7968	0·87	86·6	− 1·4	14·11	84·8	18 4 30	9 10 42	86·8	13·87	85·0	V.	·65802	8·1117	8·1113	+ ·0004	8·1115		
„ „	14 59	2·7974	0·76	86·1	„	13·13	86·0	18 5 57	9 11 19	86·8	13·39	85·9	V.	·65849	8·1046	8·1049	− ·0003	8·1047		
„ 30	12 12	2·7959	0·85	91·0	− 1·7	14·10	86·3	18 4 25	9 10 37	90·1	13·84	86·7	P.	·65876	8·1154	8·1154	·0000	8·1154		
„ „	14 50	2·7973	0·85	89·8	„	13·08	87·8	18 4 47	9 10 55	89·7	13·34	87·3	P.	·65864	8·1092	8·1085	+ ·0007	8·1088		
May 7	12 41	2·7991	0·87	90·8	− 2·1	13·37	88·5	18 3 41	9 10 26	90·9	13·27	88·9	V.	·65796	8·1077	8·1064	+ ·0013	8·1070		
„ „	14 57	2·7991	0·82	89·4	„	12·97	88·9	18 3 55	9 10 35	90·6	13·08	88·9	V.	·65799	8·1061	8·1044	+ ·0017	8·1052		
„ 14	11 49	2·7990	0·87	89·2	− 1·5	13·05	86·9	18 4 45	9 11 3	89·8	13·00	87·3	V.	·65816	8·1038	8·1018	+ ·0020	8·1028		
„ „	14 54	2·7992	0·82	88·6	„	12·74	88·0	18 4 36	9 11 1	89·6	12·87	87·9	V.	·65810	8·1036	8·1014	+ ·0022	8·1025	8·1067	3·7378
„ 21	12 15	2·7988	0·85	90·6	− 2·0	13·22	87·8	18 3 47	9 10 32	90·2	13·13	87·9	P.	·65799	8·1087	8·1070	+ ·0017	8·1078		
„ „	14 52	2·7990	0·87	90·7	„	12·72	88·9	18 3 58	9 10 40	90·3	12·94	88·5	P.	·65816	8·1076	8·1055	+ ·0021	8·1065		
„ 28	11 58	2·7976	0·90	87·1	− 3·2	14·17	83·6	18 3 20	9 10 17	87·7	14·16	83·9	V.	·65776	8·1128	8·1113	+ ·0015	8·1120		
„ „	14 48	2·7989	0·89	89·1	„	13·58	84·8	18 3 16	9 10 14	88·6	13·87	84·1	V.	·65769	8·1104	8·1089	+ ·0015	8·1096		
June 4	12 26	2·7970	0·92	89·0	− 3·5	13·55	86·0	18 3 25	9 10 25	88·7	13·37	86·0	P.	·65804	8·1152	8·1130	+ ·0022	8·1141		
„ „	14 53	2·7984	0·89	89·0	„	13·07	86·8	18 3 45	9 10 32	88·8	13·21	86·4	P.	·65793	8·1098	8·1079	+ ·0019	8·1088		
„ 11	11 54	2·7985	0·88	89·3	− 2·4	13·33	87·1	18 3 12	9 10 10	89·8	13·30	87·4	V.	·65778	8·1109	8·1098	+ ·0011	8·1103		
„ „	14 43	2·8005	0·86	89·9	„	12·73	88·0	18 3 25	9 10 12	90·7	13·03	87·9	V.	·65761	8·1040	8·1035	+ ·0005	8·1037	8·1067	3·7378
„ 18	12 19	2·7991	0·88	86·8	− 2·9	13·03	84·0	18 5 35	9 11 17	86·8	12·92	84·0	P.	·65787	8·1010	8·1003	+ ·0007	8·1006		
„ „	14 54	2·7993	0·89	88·1	„	12·56	85·0	18 6 1	9 11 30	87·4	12·47	84·6	P.	·65807	8·0995	8·0988	+ ·0007	8·0991		
„ 25	12 12	2·7967	0·76	84·7	− 3·3	14·19	83·9	18 4 34	9 10 45	84·6	14·06	83·9	V.	·65781	8·1120	8·1117	+ ·0003	8·1118		
„ „	14 52	2·7979	0·81	84·1	„	13·57	83·7	18 5 21	9 11 13	84·0	13·79	83·7	V.	·65787	8·1057	8·1048	+ ·0009	8·1052		
July 2	12 13	2·7968	0·81	85·7	− 3·6	14·01	83·1	18 4 17	9 10 35	86·1	13·88	83·4	P.	·65790	8·1122	8·1120	+ ·0002	8·1121		
„ „	14 48	2·7975	0·78	86·1	„	13·37	84·3	18 4 40	9 10 45	86·1	13·68	84·0	P.	·65804	8·1092	8·1090	+ ·0002	8·1091		
„ 9	12 39	2·7984	0·78	88·6	− 3·9	13·67	84·8	18 3 34	9 10 8	88·7	13·55	85·0	V.	·65767	8·1104	8·1107	− ·0003	8·1105		
„ „	15 11	2·7993	0·68	88·5	„	12·95	85·7	18 4 1	9 10 29	88·7	13·26	85·4	V.	·65781	8·1062	8·1057	+ ·0005	8·1059		
„ 16	12 9	2·7987	0·76	88·5	− 2·7	13·65	85·0	18 3 10	9 9 55	88·9	13·62	85·5	P.	·65757	8·1107	8·1113	− ·0006	8·1110	8·1101	3·7394
„ „	14 53	2·7987	0·76	88·5	„	13·11	86·5	18 3 31	9 10 7	88·5	13·30	86·2	P.	·65770	8·1098	8·1102	− ·0004	8·1100		
„ 23	11 58	2·7978	0·78	88·2	− 3·6	14·11	84·2	18 2 47	9 9 51	89·1	13·82	84·6	V.	·65755	8·1141	8·1137	+ ·0004	8·1139		
„ „	14 44	2·7997	0·70	88·0	„	13·16	85·4	18 3 15	9 10 5	89·4	13·51	85·0	V.	65·752	8·1068	8·1064	+ ·0004	8·1066		
„ 30	12 21	2·7977	0·77	87·2	− 3·9	13·69	84·1	18 3 50	9 10 27	86·0	13·62	84·5	P.	65·773	8·1126	8·1117	+ ·0009	8·1121		
„ „	14 53	2·7978	0·74	86·2	„	13·19	84·9	18 4 10	9 10 40	86·0	13·35	84·9	P.	65·782	8·1102	8·1089	+ ·0013	8·1095		

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Aug.	6	11 57	2·7968	0·67	81·3	−4·3	14·12	80·8	18	5 17	9 11 21	81·7	13·96	80·9	V.	·65761	8·1090	8·1068	+·0022	8·1079				
,,	,,	14 48	2·7980	0·77	80·9	,,	13·58	81·5	18	5 32	9 11 30	81·8	13·77	81·3	V.	·65754	8·1040	8·1016	+·0024	8·1028				
,,	13	12 22	2·7974	0·68	84·7	−2·8	13·90	82·2	18	4 22	9 10 52	84·5	13·82	82·5	P.	·65772	8·1111	8·1092	+·0019	8·1101				
,,	,,	14 51	2·7977	0·75	83·8	,,	13·48	83·0	18	4 47	9 11 5	84·7	13·59	83·0	P.	·65779	8·1077	8·1057	+·0020	8·1067				
,,	20	12 3	2·7975	0·57	83·8	−2·6	14·29	80·9	18	3 57	9 10 35	84·0	14·22	81·1	V.	·65746	8·1122	8·1107	+·0015	8·1114		8·1089	3·7389	
,,	,,	14 50	2·7986	0·55	83·0	,,	13·83	81·7	18	4 35	9 10 49	83·9	14·03	81·5	V.	·65740	8·1062	8·1053	+·0009	8·1057				
,,	27	12 19	2·7967	0·68	84·5	−1·9	14·41	81·4	18	3 37	9 10 32	84·3	14·28	81·7	P.	·65763	8·1158	8·1135	+·0023	8·1146				
,,	,,	14 59	2·7974	0·71	85·2	,,	13·62	83·1	18	3 51	9 10 42	84·9	13·81	82·6	P.	·65773	8·1132	8·1105	+·0027	8·1118				
Sept.	3	12 26	2·7981	0·61	86·0	−3·1	14·09	81·8	18	3 50	9 10 31	86·0	13·95	82·0	V.	·65755	8·1109	8·1094	+·0015	8·1101				
,,	,,	15 13	2·7989	0·68	85·2	,,	13·41	82·7	18	4 36	9 11 1	85·7	13·61	82·3	V.	·65766	8·1051	8·1029	+·0022	8·1040				
,,	10	12 13	2·7974	0·68	85·2	−4·5	13·91	82·9	18	4 0	9 10 37	85·5	13·87	83·0	P.	·65769	8·1119	8·1104	+·0015	8·1111				
,,	,,	14 51	2·7975	0·66	84·6	,,	13·31	83·3	18	4 17	9 10 47	86·1	13·51	83·1	P.	·65785	8·1094	8·1077	+·0017	8·1085				
,,	17	12 36	2·7992	0·63	86·4	−7·3	13·53	83·0	18	4 2	9 10 40	85·9	13·43	83·3	V.	·65739	8·1070	8·1051	+·0019	8·1060		8·1067	3·7378	
,,	,,	15 0	2·7996	0·67	85·9	,,	13·28	84·0	18	4 22	9 10 47	86·5	13·34	83·8	V.	·65740	8·1033	8·1020	+·0013	8·1026				
,,	24	12 4	2·7987	0·76	85·2	−4·6	13·94	81·3	18	4 19	9 10 42	84·7	13·94	81·7	V.	·65742	8·1074	8·1064	+·0010	8·1069				
,,	,,	14 51	2·7991	0·77	84·6	,,	13·55	82·0	18	4 22	9 10 50	85·1	13·75	81·9	V.	·65743	8·1051	8·1033	+·0018	8·1042				
Oct.	1	12 16	2·7978	0·77	85·6	−5·1	14·20	82·6	18	3 27	9 10 17	85·6	14·01	82·9	V.	·65737	8·1126	8·1115	+·0011	8·1120				
,,	,,	15 17	2·7994	0·80	84·8	,,	13·29	83·8	18	3 41	9 10 21	85·4	13·58	83·4	V.	·65717	8·1066	8·1059	+·0007	8·1062				
,,	8	12 31	2·7980	0·70	85·9	−3·5	13·81	82·9	18	3 49	9 10 30	85·5	13·59	83·2	P.	·65746	8·1113	8·1100	+·0013	8·1106				
,,	,,	14 53	2·7989	0·69	85·2	,,	13·29	84·0	18	4 15	9 10 46	85·6	13·38	83·9	P.	·65748	8·1064	8·1048	+·0016	8·1056				
,,	15	12 9	2·7989	0·76	89·1	−8·5	14·01	84·4	18	1 34	9 9 29	88·6	13·95	84·7	V.	·65714	8·1167	8·1147	+·0020	8·1157		8·1087	3·7388	
,,	,,	14 49	2·7999	0·75	87·8	,,	13·47	85·3	18	2 29	9 9 53	88·5	13·67	85·1	V.	·65716	8·1094	8·1079	+·0015	8·1086				
,,	22	12 00	2·8000	0·73	89·2	−3·3	13·62	83·0	18	2 31	9 9 51	88·9	13·56	83·5	C.	·65719	8·1100	8·1087	+·0013	8·1093				
,,	,,	14 46	2·8004	0·73	87·9	,,	13·24	85·1	18	2 37	9 9 55	89·5	13·40	84·8	C.	·65711	8·1066	8·1053	+·0013	8·1059				
,,	29	11 57	2·7991	0·75	86·4	−1·3	14·34	80·9	18	3 13	9 10 11	86·6	14·13	81·0	V.	·65714	8·1098	8·1087	+·0011	8·1092				
,,	,,	14 31	2·8000	0·72	85·5	,,	13·69	82·7	18	3 35	9 10 27	86·6	13·80	82·3	V.	·65713	8·1051	8·1033	+·0018	8·1042				
Nov.	5	11 56	2·8002	0·74	86·4	−5·2	14·02	82·5	18	3 15	9 10 12	87·3	13·86	82·9	C.	·65696	8·1055	8·1044	+·0011	8·1049				
,,	,,	14 44	2·8003	0·74	85·9	,,	13·40	83·3	18	3 28	9 10 21	86·7	13·63	83·1	C.	·65710	8·1046	8·1031	+·0015	8·1038				
,,	12	12 38	2·7998	0·87	87·1	+0·7	14·00	81·7	18	3 25	9 10 22	87·8	13·84	82·0	V.	·65723	8·1064	8·1048	+·0016	8·1056				
,,	,,	15 12	2·8006	0·98	84·6	,,	13·27	83·7	18	4 23	9 10 47	87·8	13·39	83·1	V.	·65720	8·0984	8·0971	+·0013	8·0977				
,,	19	11 59	2·7994	0·88	85·0	+1·1	14·67	79·0	18	3 42	9 10 31	85·3	14·51	79·5	C.	·65711	8·1074	8·1055	+·0019	8·1064		8·1036	3·7364	
,,	,,	14 50	2·8001	0·85	82·4	,,	14·08	81·4	18	3 51	9 10 36	85·3	14·24	80·8	C.	·65689	8·1025	8·1007	+·0018	8·1016				
,,	26	12 2	2·7983	0·92	83·5	+6·9	15·10	77·4	18	4 31	9 10 52	82·5	14·82	78·0	V.	·65725	8·1094	8·1079	+·0015	8·1086				
,,	,,	15 6	2·7999	0·86	82·0	,,	14·07	79·7	18	4 49	9 11 2	83·6	14·31	78·9	V.	·65711	8·1014	8·0997	+·0017	8·1005				
Dec.	3	12 34	2·7994	0·81	83·7	+7·4	15·13	77·9	18	3 52	9 10 32	84·2	15·02	78·4	C.	·65704	8·1074	8·1059	+·0015	8·1066				
,,	,,	14 51	2·7999	0·82	83·2	,,	14·55	79·9	18	4 24	9 10 47	84·3	14·75	79·4	C.	·65713	8·1033	8·1020	+·0013	8·1026				
,,	10	12 4	2·7994	0·85	84·2	+7·6	14·84	78·0	18	4 43	9 10 56	82·8	14·63	78·2	V.	·65713	8·1059	8·1048	+·0011	8·1053				
,,	,,	15 3	2·7990	0·87	80·2	,,	14·41	79·2	18	4 21	9 10 52	83·8	14·49	78·9	V.	·65705	8·1040	8·1020	+·0020	8·1030				
,,	17	12 7	2·7979	0·85	80·2	+7·9	15·39	77·9	18	4 17	9 10 52	80·2	15·33	77·9	P.	·65699	8·1107	8·1085	+·0022	8·1096				
,,	,,	14 51	2·7981	0·86	81·6	,,	15·05	78·5	18	4 30	9 11 0	80·5	15·16	78·1	P.	·65719	8·1102	8·1077	+·0025	8·1089		8·1064	3·7377	
,,	24	12 42	2·7988	0·98	83·6	+7·2	15·14	77·8	18	2 49	9 10 1	85·3	14·93	78·0	V.	·65686	8·1115	8·1100	+·0015	8·1107				
,,	,,	14 48	2·8010	1·09	85·7	,,	14·49	79·1	18	3 1	9 10 11	86·4	14·65	78·7	V.	·65676	8·1049	8·1029	+·0020	8·1039				
,,	31	11 58	2·7994	0·92	82·2	+8·1	15·31	75·6	18	3 21	9 10 15	82·3	15·19	76·3	C.	·65664	8·1096	8·1083	+·0013	8·1089				
,,	,,	14 34	2·8006	0·90	81·9	,,	14·79	78·1	18	3 34	9 10 25	82·4	14·91	77·7	C	·65646	8·1049	8·1033	+·0016	8·1041				
																				The mean value of the Horizontal Force for the year 1879 =		8·1074	3·7382	

b Uncorrected for rate of Chronometer.

Absolute Magnetical Observations.—Table II.

Observations of Absolute Declination.

1879.

1879. Date.	Bombay Civil Time.	Mean Readings. Collimator Magnet. Scale apparently Erect.	Mean Readings. Collimator Magnet. Scale apparently Inverted.	Mean Readings. Horizontal Circle with Telescope pointed to. Scale of Collimator Magnet.	Mean Readings. Horizontal Circle with Telescope pointed to. Tardeo Chimney.	Torsion. Mean.	Torsion. Effect of 90°.	Observer.	Corresponding Reading of large Declination Magnetometer.	Absolute Easterly Declination corrected for Torsion.	Monthly Mean. Corresponding Reading of large Declination Magnetometer.	Monthly Mean. Absolute Easterly Declination.
1	2	3	4	5	6	7	8	9	10	11	12	13
	h. m.	Sc. div.	Sc. div.	° ′ ″	° ′ ″	°	Sc. div.		Sc. div.	° ′ ″	Sc. div.	° ′ ″
JAN. 3	11 9	+1·52	+1·64	17 20 40	196 50 5	0		P.	36·89	0 56 53		
„ 9	11 26	+1·54	+1·54	17 20 30	196 49 57	0		P.	36·91	0 56 59		
„ 16	11 15	+1·52	+1·66	17 20 52	196 49 42	0		C.	36·99	0 57 27	36·91	0 56 58
„ 23	11 39	+1·52	+1·61	17 22 40	196 51 22	15 E.	0·82	P.	37·01	0 57 39		
„ 30	11 34	+1·52	+1·64	17 20 0	196 50 25	0		V.	36·76	0 55 53		
FEB. 6	11 6	+1·55	+1·62	17 23 20	196 51 20	0		P.	37·15	0 58 22		
„ 13	11 21	+1·55	+1·57	17 22 7	196 51 40	0		V.	36·91	0 56 52	36·98	0 57 20
„ 20	11 11	+1·57	+1·54	17 22 00	196 51 0	0		P.	36·98	0 57 27		
„ 27	11 15	+1·55	+1·54	17 21 2	196 50 57	12 W.	0·42	V.	36·89	0 56 39		
MAR. 6	11 26	+1·52	+1·60	17 22 15	196 51 15	0		P.	36·99	0 57 20		
„ 13	11 20	+1·49	+1·75	17 22 32	196 51 37	0		V.	36·94	0 57 3	37·00	0 57 29
„ 20	11 13	+1·52	+1·60	17 22 35	196 51 20	0		P.	37·01	0 57 35		
„ 27	11 26	+1·50	+1·61	17 22 7	196 50 27	0		V.	37·07	0 57 59		
APRIL 3	11 21	+1·49	+1·65	17 21 20	196 50 20	0		P.	36·99	0 57 15		
„ 10	11 18	+1·59	+1·51	17 21 22	196 50 17	0		V.	37·03	0 57 37	36·90	0 56 41
„ 17	11 12	+1·52	+1·60	17 20 20	196 50 25	12 E.	0·50	P.	36·82	0 56 6		
„ 24	11 29	+1·51	+1·55	17 19 50	196 50 27	0		V.	36·75	0 55 46		
MAY 1	11 21	+1·55	+1·50	17 20 50	196 51 15	0		P.	36·80	0 56 4		
„ 8	11 25	+1·50	+1·52	17 20 22	196 50 2	0		V.	36·89	0 56 45		
„ 15	11 29	+1·52	+1·52	17 17 52	196 50 0	0		V.	36·51	0 54 18	36·75	0 55 48
„ 22	11 18	+1·55	+1·59	17 19 20	196 50 17	0		P.	36·70	0 55 26		
„ 29	11 13	+1·50	+1·62	17 20 17	196 50 7	0		V.	36·85	0 56 28		
JUNE 5	11 12	+1·54	+1·62	17 20 40	196 50 0	15 W.	0·52	P.	36·96	0 57 12		
„ 12	11 20	+1·54	+1·61	17 19 52	196 50 5	0		V.	36·80	0 56 9	36·84	0 56 21
„ 19	11 22	+1·52	+1·59	17 20 00	196 50 50	0		P.	36·73	0 55 32		
„ 26	11 13	+1·51	+1·72	17 20 17	196 49 57	0		V.	36·87	0 56 32		
JULY 3	11 12	+1·47	+1·62	17 18 50	196 50 25	0		P.	36·58	0 54 41		
„ 10	11 19	+1·45	+1·75	17 20 55	196 51 10	0		V.	36·77	0 55 50		
„ 17	11 16	+1·52	+1·61	17 21 00	196 50 40	0		P.	36·90	0 56 40	36·75	0 55 44
„ 24	11 25	+1·46	+1·62	17 23 12	196 52 0	0		V.	37·03	0 57 27		
„ 31	11 29	+1·47	+1·62	17 18 20	196 50 35	0		P.	36·48	0 54 1		
AUG. 7	11 16	+1·51	+1·69	17 21 12	196 52 2	0		V.	36·74	0 55 24		
„ 14	11 13	+1·52	+1·62	17 21 10	196 51 0	0		P.	36·89	0 56 29	36·79	0 55 45
„ 22	11 23	+1·52	+1·67	17 20 10	196 50 42	0		V.	36·79	0 55 44		
„ 28	11 20	+1·52	+1·62	17 20 20	196 51 15	0		P.	36·73	0 55 24		
SEPT. 4	11 19	+1·54	+1·62	17 21 5	196 51 32	0		V.	36·82	0 55 53		
„ 11	11 13	+1·52	+1·60	17 21 15	196 50 20	0		P.	37·01	0 57 15	36·88	0 56 21
„ 18	11 21	+1·52	+1·76	17 19 52	196 50 17	0		V.	36·79	0 55 44		
„ 25	11 20	+1·55	+1·59	17 20 22	196 50 12	0		V.	36·92	0 56 33		
OCT. 2	11 20	+1·47	+1·77	17 20 22	196 50 27	0		V.	36·84	0 56 0		
„ 9	11 12	+1·51	+1·62	17 19 45	196 50 22	0		P.	36·80	0 55 36		
„ 16	11 28	+1·55	+1·57	17 20 20	196 50 55	0		V.	36·83	0 55 50	36·83	0 55 52
„ 23	11 20	+1·55	+1·57	17 19 47	196 50 17	0		C.	36·83	0 55 55		
„ 30	11 21	+1·59	+1·40	17 19 15	196 49 52	0		V.	36·84	0 56 1		
NOV. 6	11 20	+1·55	+1·52	17 18 2	196 49 45	0		C.	36·64	0 54 44		
„ 13	11 31	+1·50	+1·67	17 19 55	196 49 50	0		V.	36·89	0 56 20	36·81	0 55 50
„ 20	11 16	+1·59	+1·55	17 19 7	196 49 45	0		C.	36·82	0 55 51		
„ 27	11 26	+1·52	+1·57	17 19 57	196 49 55	0		V.	36·91	0 56 25		
DEC. 4	11 15	+1·57	+1·55	17 21 20	196 50 30	10 E.	0·79	C.	37·01	0 57 5		
„ 11	11 33	+1·52	+1·56	17 22 47	196 51 7	0		V.	37·14	0 58 3	36·97	0 56 59
„ 18	11 16	+1·57	+1·57	17 21 40	196 51 17	0		P.	36·92	0 56 49		
„ 25	11 37	+1·50	+1·66	17 21 32	196 51 47	0		V.	36·82	0 56 0		

The Mean Declination for the year 1879 = 0° 56′ 26″

Absolute Magnetical Observations.—Table III.

OBSERVATIONS OF INCLINATION, 1879.

Taken with Barrow's Dip Circle, with Microscopes, No. 49, and a 3½ inch Needle, No. 5 by Adie.

1879. Date.	Bombay Civil Time (0 to 24 hours). At commencement.	At conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JAN. 3	15 14	16 21	P.	5	19 8·9	19 18·7	19 22·9	19 35·4	19 21·4	
„ 7	10 58	12 6	P.	5	19 8·1	19 14·6	19 27·7	19 40·9	19 22·8	
„ 10	15 10	16 16	P.	5	19 1·2	19 19·7	19 28·0	19 35·7	19 21·1	
„ 14	10 54	12 15	V.	5	18 56·6	19 24·6	19 23·6	19 47·7	19 23·1	
„ 17	15 6	16 13	C.	5	19 7·8	19 26·5	19 17·7	19 38·8	19 20·1	19 21·3
„ 21	10 51	11 56	P.	5	19 11·2	19 8·7	19 18·9	19 33·7	19 18·1	
„ 24	15 10	16 23	P.	5	18 58·1	19 15·7	19 30·2	19 35·8	19 19·9	
„ 28	10 52	12 8	V.	5	18 57·2	19 16·7	19 32·2	19 39·1	19 21·2	
„ 31	14 56	16 17	V.	5	19 1·1	19 17·3	19 28·0	19 48·9	19 23·8	
FEB. 4	10 55	12 3	P.	5	19 11·2	19 11·9	19 19·4	19 43·8	19 21·5	
„ 7	15 4	16 11	P.	5	19 9·4	19 11·1	19 16·7	19 47·7	19 21·2	
„ 11	11 4	12 15	C.	5	19 9·3	19 18·5	19 25·1	19 34·4	19 21·8	
„ 14	15 16	16 29	V.	5	19 6·5	19 11·2	19 36·1	19 37·7	19 22·8	19 22·0
„ 18	10 55	12 2	P.	5	19 8·9	19 11·4	19 25·7	19 40·6	19 21·6	
„ 21	15 8	16 17	P.	5	19 2·9	19 12·2	19 32·1	19 37·2	19 21·0	
„ 25	11 12	12 31	V.	5	18 56·6	19 11·3	19 34·1	19 52·0	19 23·4	
„ 28	15 14	16 27	V.	5	18 59·7	19 13·0	19 32·9	19 45·7	19 22·8	
MARCH 4	10 56	12 13	P.	5	19 9·6	19 15·7	19 24·6	19 42·1	19 22·9	
„ 7	15 2	16 16	P.	5	18 59·0	19 12·5	19 21·6	19 51·6	19 21·1	
„ 11	11 6	12 22	V.	5	19 0·7	19 18·4	19 30·9	19 42·5	19 23·1	
„ 14	15 17	16 34	V.	5	19 0·3	19 15·3	19 29·6	19 46·9	19 23·0	
„ 18	10 56	12 10	P.	5	19 3·6	19 19·0	19 22·5	19 43·4	19 22·1	19 22·0
„ 21	15 11	16 22	P.	5	18 57·6	19 16·9	19 24·2	19 43·5	19 20·5	
„ 25	11 4	12 11	V.	5	19 3·1	19 11·9	19 30·1	19 46·1	19 22·8	
„ 28	15 11	16 25	V.	5	18 59·6	19 13·4	19 29·4	19 45·4	19 21·9	
„ 31	10 58	12 12	P.	5	19 0·9	19 19·7	19 24·1	19 39·3	19 21·0	
APRIL 4	15 2	16 16	P.	5	19 5·6	19 17·6	19 26·2	19 34·7	19 21·0	
„ 8	11 12	12 22	V.	5	18 58·6	19 12·1	19 32·7	19 47·6	19 22·7	
„ 11	15 2	16 45	V.N.	5	19 58·2	19 56·1	18 45·0	18 58·2	19 24·3	
„ 15	11 18	12 31	V.	5	19 7·8	19 14·9	19 29·8	19 45·2	19 24·4	
„ 18	15 4	16 22	P.	5	19 14·5	19 22·4	19 21·1	19 38·8	19 24·1	19 23·2
„ 22	11 15	12 33	V.	5	19 14·6	19 12·4	19 29·9	19 42·2	19 24·7	
„ 25	15 5	16 23	V.	5	19 13·2	19 20·0	19 30·2	19 19·8	19 20·8	
„ 29	10 55	12 7	P.	5	19 9·5	19 16·8	19 32·4	19 37·6	19 24·0	
MAY 2	15 6	16 19	P.	5	19 11·0	19 10·3	19 24·3	19 44·6	19 22·5	
„ 6	11 5	12 22	V.	5	19 17·0	19 30·3	19 27·6	19 20·1	19 23·7	
„ 9	15 10	16 31	V.	5	19 29·1	19 11·7	19 17·9	19 26·9	19 21·4	
„ 13	11 10	12 31	V.	5	19 29·2	19 26·7	19 17·5	19 18·7	19 23·0	
„ 16	15 6	16 18	P.	5	18 58·7	19 18·9	19 28·4	19 35·9	19 20·4	19 21·9
„ 20	10 55	12 7	P.	5	19 3·9	19 17·3	19 22·0	19 42·4	19 21·4	
„ 23	15 3	16 18	P.	5	19 2·9	19 23·4	19 23·4	19 43·5	19 23·2	
„ 27	11 5	12 25	V.	5	19 24·2	19 20·7	19 16·0	19 21·5	19 20·5	
„ 30	15 10	16 27	V.	5	19 21·9	19 23·1	19 20·0	19 19·6	19 21·1	
JUNE 3	10 55	12 5	P.	5	19 20·3	19 18·9	19 18·7	19 28·0	19 21·4	
„ 6	15 8	16 22	P.	5	19 10·5	19 16·7	19 25·9	19 33·0	19 21·5	
„ 10	10 56	12 18	V.	5	19 20·2	19 24·0	19 16·7	19 26·4	19 21·8	
„ 13	14 55	16 4	V.	5	19 20·8	19 22·8	19 18·3	19 26·6	19 22·1	19 21·7
„ 17	10 58	12 9	P.	5	19 8·9	19 20·1	19 34·9	19 30·7	19 23·6	
„ 20	15 5	16 18	P.	5	19 7·8	19 14·8	19 36·1	19 31·0	19 22·4	
„ 24	11 4	12 30	V.	5	19 17·1	19 19·2	19 22·3	19 26·9	19 21·3	
„ 27	15 9	16 31	V.	5	19 25·0	19 15·3	19 12·2	19 26·7	19 19·7	
JULY 1	11 3	12 8	P.	5	19 11·3	19 29·4	19 22·4	19 31·4	19 23·6	
„ 4	15 12	16 24	P.	5	19 12·7	19 23·3	19 28·1	19 32·4	19 24·1	
„ 8	11 5	12 30	V.	5	19 25·6	19 17·0	19 20·6	19 23·8	19 21·7	

1879. Date.	Bombay Civil Time (0 to 24 hours). At commencement.	At conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JULY 11	15 10	16 22	V.	5	19 24·1	19 7·7	19 10·6	19 35·3	19 19·4	
„ 15	10 55	12 7	P.	5	19 21·1	19 11·7	19 20·4	19 37·7	19 22·7	
„ 18	15 3	16 16	P.	5	19 17·5	19 12·2	19 17·8	19 32·9	19 20·0	19 21·9
„ 22	10 55	12 14	V.	5	19 24·3	18 59·9	19 26·7	19 40·2	19 22·7	
„ 25	15 5	16 30	V.	5	19 28·3	18 54·4	19 37·0	19 29·3	19 22·2	
„ 29	10 58	12 6	P.	5	19 14·6	19 12·7	19 21·2	19 34·1	19 20·6	
AUG. 2	15 10	16 24	P.	5	19 19·0	19 7·6	19 30·4	19 39·7	19 24·1	
„ 5	10 52	12 12	V.	5	19 22·1	19 5·6	19 31·9	19 28·9	19 22·1	
„ 8	14 54	16 14	V.	5	19 22·4	19 2·8	19 30·7	19 36·1	19 23·0	
„ 12	10 53	12 5	P.	5	19 13·4	19 10·4	19 32·1	19 36·0	19 22·9	
„ 15	15 2	16 15	P.	5	19 10·0	19 23·0	19 27·0	19 33·5	19 23·3	19 22·6
„ 19	11 10	12 34	V.	5	19 6·3	19 22·6	19 29·1	19 30·6	19 22·1	
„ 22	15 4	16 24	V.	5	19 15·9	19 18·8	19 25·9	19 36·7	19 24·3	
„ 26	10 59	12 16	P.	5	19 7·9	19 9·9	19 28·9	19 36·0	19 20·6	
„ 29	15 4	16 21	P.	5	19 8·2	19 19·9	19 25·4	19 31·6	19 21·2	
SEPT. 2	11 10	12 32	V.	5	19 15·1	19 8·1	19 31·2	19 34·4	19 22·2	
„ 5	15 7	16 31	V.	5	19 4·7	19 18·4	19 37·1	19 32·7	19 23·2	
„ 9	10 58	12 10	P.	5	19 5·1	19 20·1	19 24·1	19 40·9	19 22·5	
„ 12	15 2	16 15	P.	5	19 3·1	19 16·5	19 29·1	19 36·1	19 21·2	
„ 16	11 4	12 24	V.	5	19 5·1	19 11·4	19 35·6	19 38·9	19 22·7	19 22·2
„ 19	15 15	16 25	V.	5	19 2·6	19 13·6	19 31·6	19 37·8	19 21·4	
„ 23	10 52	11 57	P.	5	19 3·1	19 19·9	19 26·6	19 41·5	19 22·7	
„ 26	15 6	16 16	P.	5	18 57·3	19 14·9	19 30·9	19 47·6	19 22·6	
„ 30	11 5	12 26	V.	5	19 8·1	19 12·4	19 28·9	19 35·1	19 21·1	
OCT. 3	15 4	16 29	V.	5	19 0·7	19 17·2	19 30·4	19 43·9	19 23·0	
„ 7	10 55	12 2	P.	5	19 1·1	19 15·5	19 32·0	19 45·0	19 23·4	
„ 10	15 5	16 20	P.	5	18 54·7	19 12·3	19 32·9	19 46·1	19 21·5	
„ 14	11 10	12 33	V.	5	19 20·1	19 14·6	19 31·6	19 32·2	19 24·6	
„ 17	15 11	16 34	V.	5	19 19·8	19 39·6	19 16·0	19 13·2	19 22·1	19 22·6
„ 21	11 1	12 25	C.	5	19 17·3	19 17·7	19 16·8	19 27·6	19 19·8	
„ 25	15 12	16 27	C.	5	19 15·9	19 20·6	19 10·6	19 37·1	19 21·0	
„ 28	11 5	12 31	V.	5	19 40·4	19 24·6	19 15·1	19 16·5	19 24·1	
„ 31	15 4	16 11	V.	5	19 19·1	19 25·4	19 27·8	19 25·0	19 24·3	
NOV. 4	11 6	12 23	C.	5	19 11·4	19 14·3	19 23·1	19 45·5	19 23·5	
„ 7	15 11	16 26	C.	5	19 16·2	19 15·9	19 27·8	19 25·4	19 21·3	
„ 11	11 6	12 14	V.	5	19 17·0	19 20·1	19 28·7	19 30·6	19 24·0	
„ 14	15 2	16 12	C.	5	19 16·6	19 20·2	19 25·0	19 32·4	19 23·5	19 23·0
„ 18	10 59	12 14	C.	5	19 18·1	19 16·2	19 18·2	19 35·5	19 21·9	
„ 21	15 12	16 20	C.	5	19 8·7	19 23·7	19 22·9	19 33·8	19 22·2	
„ 25	11 2	12 17	V.	5	19 10·9	19 27·9	19 20·8	19 37·1	19 24·1	
„ 28	15 2	16 12	V.	5	19 13·7	19 22·7	19 26·1	19 30·8	19 23·3	
DEC. 2	11 0	12 9	C.	5	19 28·1	19 23·9	19 10·4	19 37·2	19 24·9	
„ 5	15 8	16 17	C.	5	19 18·2	19 22·4	19 20·9	19 25·9	19 21·8	
„ 9	11 5	12 21	V.	5	19 16·6	19 19·5	19 27·7	19 31·5	19 23·8	
„ 12	15 1	16 17	V.	5	19 16·7	19 20·2	19 21·1	19 24·5	19 20·6	
„ 16	10 42	11 58	P.	5	19 12·9	19 18·4	19 22·3	19 36·4	19 22·4	19 21·9
„ 19	15 4	16 20	P.	5	19 10·5	19 23·1	19 22·4	19 35·0	19 22·7	
„ 23	11 4	12 16	V.	5	19 5·2	19 22·1	19 31·0	19 40·8	19 24·7	
„ 27	15 3	16 16	P.	5	19 6·7	19 20·2	19 21·0	19 38·9	19 21·6	
„ 30	11 10	12 55	V.N.	5	19 49·2	19 58·1	18 43·0	18 29·4	19 14·9	

The Mean Dip for the year 1879 = ° 19 22·2

Absolute Magnetical Observations.—Table IV.

Observations of Vibration and Deflection, taken with the Kew Unifilar Magnetometer (No. 23, by Elliott Brothers), for the determination of Absolute Horizontal Force.

1880.

1880. Date.	Civil Time. Mean.	Magnet N. 23 *a*. Time of one Vibration *b*.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 *c* by N. 23 *a* at. Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance. 0·8 foot ($X_{0\cdot8}$)	1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8} - X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
Jan. 7	12 18	2·7990	1·04	86·2	+7·7	15·53	78·0	18 1 42	9 9 25	85·8	15·46	78·4	V.	·65676	8·1165	8·1154	+·0011	8·1159		
„ „	14 37	2·8013	1·12	85·5	„	14·44	80·4	18 2 31	9 9 46	85·8	14·91	79·8	V.	·65657	8·1061	8·1055	+·0006	8·1058		
„ 14	12 5	2·7992	1·00	81·2	+6·8	15·44	76·0	18 2 39	9 9 47	80·8	15·30	76·3	P.	·65621	8·1128	8·1126	+·0002	8·1127		
„ „	14 40	2·8000	1·04	82·9	„	14·68	78·2	18 3 1	9 9 57	81·2	14·96	77·6	P.	·65639	8·1102	8·1098	+·0004	8·1100	8·1108	3·7397
„ 21	12 5	2·7979	1·03	79·6	+6·7	15·33	75·9	18 3 53	9 10 23	79·3	15·24	75·9	V.	·65664	8·1120	8·1119	+·0001	8·1119		
„ „	14 54	2·7999	1·10	80·0	„	14·58	77·9	18 4 2	9 10 36	79·0	15·01	77·0	V.	·65645	8·1062	8·1051	+·0011	8·1056		
„ 28	12 3	2·7997	1·08	83·7	+9·1	15·29	77·3	18 2 22	9 9 32	82·7	15·20	77·7	P.	·65631	8·1136	8·1133	−·0003	8·1131		
„ „	14 41	2·8002	1·05	85·0	„	14·62	79·1	18 2 27	9 9 37	83·3	14·92	78·7	P.	·65651	8·1117	8·1119	−·0002	8·1118		
Feb. 4	12 4	2·7992	1·07	81·9	+8·0	15·01	79·5	18 3 27	9 10 15	80·5	14·89	79·9	V.	·65649	8·1107	8·1100	+·0007	8·1103		
„ „	14 55	2·7999	1·01	81·5	„	14·45	80·0	18 3 39	9 10 30	80·7	14·60	80·0	V.	·65654	8·1076	8·1057	+·0019	8·1066		
„ 11	12 25	2·7959	0·98	77·5	+9·2	16·24	73·6	18 3 32	9 10 22	78·2	16·08	74·1	P.	·65686	8·1188	8·1173	+·0015	8·1180		
„ „	14 51	2·7969	1·03	81·0	„	15·48	75·7	18 4 00	9 10 36	79·9	15·61	75·3	P.	·65719	8·1154	8·1141	+·0013	8·1147	8·1119	3·7402
„ 18	11 56	2·7975	0·91	77·0	+8·5	15·87	73·0	18 4 35	9 10 50	76·0	15·83	73·1	C.	·65661	8·1119	8·1109	+·0010	8·1114		
„ „	14 41	2·7977	0·95	75·0	„	15·40	74·3	18 4 49	9 10 55	75·7	15·53	74·0	C.	·65651	8·1090	8·1083	+·0007	8·1086		
„ 25	12 23	2·7980	1·00	82·0	+7·2	15·32	78·1	18 3 12	9 10 12	81·3	15·19	78·4	P.	·65678	8·1147	8·1132	+·0015	8·1139		
„ „	15 35	2·7983	0·96	81·8	„	14·70	79·0	18 3 27	9 10 25	81·7	14·82	78·9	P.	·65693	8·1124	8·1104	+·0020	8·1114		
March 3	12 16	2·7985	0·87	85·4	+7·3	14·80	80·5	18 2 22	9 9 49	84·8	14·73	80·7	C.	·65695	8·1160	8·1143	+·0017	8·1151		
„ „	14 48	2·7997	0·89	83·3	„	14·15	82·0	18 2 29	9 9 51	84·2	14·40	81·4	C.	·65661	8·1107	8·1094	+·0013	8·1100		
„ 10	12 15	2·7995	0·94	86·6	+7·8	15·01	82·5	18 1 27	9 9 25	86·2	14·88	83·3	P.	·65669	8·1161	8·1141	+·0020	8·1151		
„ „	14 48	2·8000	0·95	85·2	„	13·84	84·7	18 2 11	9 9 45	86·8	14·11	84·4	P.	·65683	8·1102	8·1085	+·0017	8·1093		
„ 17	11 48	2·8002	0·91	86·4	+6·4	14·39	83·0	18 1 50	9 9 35	86·6	14·17	83·4	C.	·65655	8·1120	8·1102	+·0018	8·1111	8·1098	3·7393
„ „	14 38	2·8009	0·93	86·4	„	13·80	84·0	18 1 58	9 9 40	86·5	13·92	84·0	C.	·65657	8·1096	8·1077	+·0019	8·1086		
„ 24	12 32	2·8001	1·12	83·4	+5·2	13·80	85·3	18 1 33	9 9 22	90·0	13·50	85·8	V.N.	·65645	8·1074	8·1061	+·0013	8·1067		
„ „	15 42	2·8028	0·97	87·1	„	13·01	86·9	18 1 52	9 9 31	90·6	13·23	86·2	V.N.	·65639	8·1012	8·0999	+·0013	8·1005		
„ 31	11 55	2·8004	0·91	90·0	+6·5	14·19	86·8	18 0 53	9 9 11	90·1	13·99	87·0	C.	·65676	8·1148	8·1126	+·0022	8·1137		
„ „	14 42	2·8019	0·85	89·4	„	13·17	88·0	18 1 17	9 9 24	89·6	13·39	87·6	C.	·65663	8·1092	8·1068	+·0024	8·1080		

1880.		Magnet N. 23 *a*.				Corresponding Mean Reading of L. H. F. Magnetometer.		Angle of Deflection of Magnet N. 23 *c* by N. 23 *a* at			Corresponding Mean Reading of L. F. H. Magnetometer.		Observer.	Calculated Results in English Units.					
Date.	Civil Time. Mean.	Time of one Vibration *b*.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Scale Reading.	Thermometer.	Distance. 0·8 foot.	Distance. 1·0 foot.	Temperature.	Scale Reading.	Thermometer.		Values of m.	Values of X. From Deflections at distance 0·8 foot ($X_{0\cdot8}$)	Values of X. From Deflections at distance 1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8}-X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
April 7	12 25	2·7998	0·96	88·7	+6·8	14·09	87·0	18 0 37	9 9 3	89·2	13·86	87·2	P.	·65663	8·1173	8·1148	+·0025	8·1160		
„ „	14 54	2·8005	0·96	88·8	„	13·25	87·9	18 0 57	9 9 15	89·5	13·49	87·6	P.	·65680	8·1137	8·1111	+·0026	8·1124		
„ 14	11 53	2·8002	0·91	90·1	+6·2	14·04	86·1	18 0 6	9 8 47	90·5	13·89	86·7	C.	·65666	8·1180	8·1158	+·0022	8·1169		
„ „	14 41	2·8008	0·89	88·0	„	13·22	88·1	18 0 27	9 9 0	89·4	13·38	87·8	C.	·65649	8·1143	8·1117	+·0026	8·1130		
„ 21	12 1	2·8004	1·02	90·4	+6·4	13·92	87·1	17 59 37	9 8 20	90·4	13·83	87·6	P.	·65643	8·1193	8·1186	+·0007	8·1189	8·1155	3·7419
„ „	14 45	2·8008	0·99	90·0	„	13·25	88·0	17 59 50	9 8 25	90·2	13·52	87·9	P.	·65649	8·1173	8·1169	+·0004	8·1171		
„ 28	11 53	2·8015	0·94	92·2	+6·0	14·56	88·0	17 57 59	9 7 33	92·3	14·34	88·2	V.	·65587	8·1219	8·1210	+·0009	8·1214		
„ „	14 33	2·8045	1·05	91·5	„	23·23	89·0	17 58 51	9 8 0	92·7	13·73	88·9	V.	·65575	8·1089	8·1077	+·0012	8·1083		
May 5	12 9	2·8014	0·97	91·8	+6·8	13·24	87·9	18 0 20	9 8 50	92·2	13·13	88·1	P.	·65664	8·1133	8·1117	+·0016	8·1125		
„ „	14 44	2·8018	0·94	92·2	„	12·69	89·2	18 0 37	9 8 57	91·9	12·79	88·9	P.	·65670	8·1119	8·1104	+·0015	8·1111		
„ 12	12 21	2·8040	0·79	91·2	+6·8	13·69	88·0	17 59 29	9 8 21	92·6	13·62	88·0	V.	·65580	8·1085	8·1072	+·0013	8·1078		
„ „	14 40	2·8045	0·85	92·0	„	13·22	89·0	17 59 41	9 8 22	93·5	13·36	88·8	V.	·65590	8·1059	8·1053	+·0006	8·1056	8·1085	3·7387
„ 19	12 19	2·8032	0·84	92·0	+6·5	13·47	88·0	17 59 47	9 8 37	92·1	13·33	88·5	P.	·65613	8·1107	8·1087	+·0020	8·1097		
„ „	14 54	2·8037	0·78	92·1	„	12·99	89·5	18 0 0	9 8 41	92·4	13·06	89·1	P.	·65613	8·1085	8·1066	+·0019	8·1075		
„ 26	12 1	2·8036	0·60	90·5	+6·3	13·47	88·3	18 0 5	9 8 35	91·5	13·34	88·8	V.	·65593	8·1081	8·1072	+·0009	8·1076		
„ „	14 47	2·8049	0·60	91·5	„	13·00	89·9	17 59 19	9 8 11	92·7	13·25	89·6	V.	·65569	8·1068	8·1062	+·0006	8·1065		
June 2	12 57	2·8050	0·68	93·0	+6·5	13·28	89·4	17 59 29	9 8 11	92·7	13·10	89·9	C.	·65565	8·1072	8·1072	·0000	8·1072		
„ „	15 6	2·8059	0·64	92·8	„	12·64	90·6	17 59 49	9 8 20	93·0	12·84	90·3	C.	·65568	8·1031	8·1031	·0000	8·1031		
„ 9	12 0	2·8044	0·69	90·8	+6·0	13·87	87·5	17 58 56	9 8 4	92·6	13·69	87·9	V.	·65548	8·1089	8·1077	+·0012	8·1083		
„ „	14 22	2·8066	0·68	92·5	„	12·95	88·9	17 59 20	9 8 15	93·6	13·24	88·3	V.	·65545	8·1018	8·1007	+·0011	8·1012		
„ 16	12 9	2·8044	0·68	92·4	+5·9	13·36	89·0	17 58 17	9 7 45	92·4	13·27	89·3	P.	·65544	8·1130	8·1117	+·0013	8·1123	8·1063	3·7377
„ „	14 55	2·8053	0·66	92·0	„	12·76	90·2	17 58 32	9 7 50	92·7	13·13	89·9	P.	·65547	8·1089	8·1079	+·0010	8·1084		
„ 23	11 53	2·8047	0·63	89·8	+5·6	13·49	87·0	18 0 21	9 8 39	91·5	12·96	87·1	V.	·65545	8·1033	8·1029	+·0004	8·1031		
„ „	14 54	2·8072	0·69	88·2	„	12·32	87·9	18 1 50	9 9 32	88·9	12·35	87·8	V.	·65531	8·0917	8·0902	+·0015	8·0909		
„ 30	12 12	2·8009	0·63	84·7	+2·5	14·49	82·0	18 0 17	9 8 47	84·6	14·42	82·4	P.	·65574	8·1161	8·1147	+·0014	8·1154		
„ „	14 49	2·8014	0·57	83·9	„	13·90	83·0	18 0 30	9 8 50	84·3	14·22	83·0	P.	·65575	8·1135	8·1124	+·0011	8·1129		
July 7	12 38	2·8016	0·58	84·0	+1·6	14·54	81·5	18 1 13	9 9 5	83·0	14·44	81·8	V.	·65562	8·1117	8·1113	+·0004	8·1115		
„ „	14 59	2·8028	0·50	81·7	„	13·88	82·0	18 1 29	9 9 17	83·6	14·07	81·9	V.	·65544	8·1048	8·1040	+·0008	8·1044		
„ 14	12 3	2·8027	0·59	86·1	+0·8	13·57	83·0	18 1 22	9 9 7	85·5	13·46	83·2	C.	·65569	8·1072	8·1072	·0000	8·1072		
„ „	14 46	2·8033	0·56	84·0	„	13·39	83·6	18 1 35	9 9 17	84·0	13·40	83·5	C.	·65542	8·1044	8·1040	+·0004	8·1042	8·1086	3·7387
„ 21	11 49	2·8022	0·51	84·6	+2·7	14·27	82·9	18 0 17	9 8 35	84·9	14·19	83·0	V.	·65538	8·1122	8·1122	·0000	8·1122		
„ „	14 20	2·8034	0·57	85·7	„	13·75	84·0	18 0 21	9 8 40	85·7	13·97	83·6	V.	·65538	8·1085	8·1081	+·0004	8·1083		
„ 28	12 13	2·8025	0·54	87·0	+2·4	14·28	83·0	18 0 16	9 8 35	85·7	14·18	83·2	P.	·65553	8·1126	8·1124	+·0002	8·1125		
„ „	14 53	2·8034	0·54	86·0	„	13·58	84·1	18 0 32	9 8 40	85·7	13·86	83·9	P.	·65547	8·1081	8·1083	−·0002	8·1082		

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Absolute Magnetical Observations.—Table V.

Observations of Absolute Declination.

1880.

1880. Date.	Bombay Civil Time.	Mean Readings. Collimator Magnet, Scale apparently Erect.	Collimator Magnet, Scale apparently Inverted.	Horizontal Circle with Telescope pointed to Scale of Collimator Magnet.	Horizontal Circle with Telescope pointed to Târdeo Chimney.	Torsion. Mean.	Torsion. Effect of 90°.	Observer.	Corresponding Reading of large Declination Magnetometer.	Absolute Easterly Declination corrected for Torsion.	Monthly Mean. Corresponding Reading of large Declination Magnetometer.	Monthly Mean. Absolute Easterly Declination.
1	2	3	4	5	6	7	8	9	10	11	12	13
	h. m.	Sc. div.	Sc. div.	° ′ ″	° ′ ″	°	Sc. div.		Sc. div.	° ′ ″	Sc. div.	° ′ ″
JAN. 1	11 22	+1·54	+1·59	17 23 0	196 52 0	0		C.	37·03	0 57 23		
„ 8	11 25	+1·55	+1·52	17 23 50	196 51 52	0		V.	37·21	0 58 25		
„ 15	11 10	+1·60	+1·67	17 23 25	196 52 00	0		P.	37·11	0 57 47	37·05	0 57 25
„ 22	11 12	+1·59	+1·36	17 21 12	196 52 15	0		V.	36·92	0 56 38		
„ 29	11 26	+1·57	+1·60	17 22 00	196 51 32	0		P.	36·99	0 56 53		
FEB. 5	11 27	+1·46	+1·71	17 23 27	196 51 30	0		V.	37·15	0 58 6		
„ 12	11 14	+1·57	+1·52	17 22 0	196 52 10	0		P.	36·92	0 56 19	37·07	0 57 23
„ 19	11 20	+1·56	+1·61	17 22 17	196 51 12	0		C.	37·09	0 57 28		
„ 26	11 21	+1·56	+1·55	17 22 20	196 51 5	0		P.	37·12	0 57 41		
MAR. 4	11 17	+1·59	+1·51	17 21 40	196 51 17	0		C.	37·01	0 56 55		
„ 11	11 15	+1·55	+1·57	17 21 30	196 50 35	0		P.	37·08	0 57 20		
„ 18	11 12	+1·55	+1·61	17 21 25	196 50 57	0		C.	37·00	0 56 50	37·10	0 57 26
„ 25	11 18	+1·47	+1·62	17 22 40	196 50 15	0		P.	37·31	0 58 41		
APRIL 1	11 21	+1·52	+1·61	17 20 40	196 49 57	0		C.	37·03	0 57 3		
„ 8	11 18	+1·51	+1·66	17 20 20	196 50 45	0		P.	36·85	0 55 51		
„ 15	11 18	+1·52	+1·62	17 20 35	196 50 25	0		C.	36·94	0 56 29	36·90	0 56 14
„ 22	11 16	+1·52	+1·65	17 20 00	196 51 10	0		P.	36·73	0 55 8		
„ 29	11 20	+1·46	+1·64	17 20 25	196 50 2	0		V.	36·95	0 56 37		
MAY 6	11 13	+1·52	+1·62	17 20 40	196 50 42	0		P.	36·91	0 56 17		
„ 13	11 24	+1·52	+1·70	17 19 2	196 50 30	0		V.	36·65	0 54 46		
„ 20	11 30	+1·52	+1·66	17 18 57	196 50 00	10E	0·68	P.	36·67	0 55 3	36·74	0 55 25
„ 27	11 17	+1·47	+1·61	17 20 00	196 50 42	0		V.	36·75	0 55 34		
JUNE 3	11 25	+1·52	+1·62	17 19 00	196 50 40	0		P.	36·59	0 54 39		
„ 10	11 18	+1·52	+1·61	17 20 0	196 50 32	0		V.	36·79	0 55 48		
„ 17	11 24	+1·51	+1·67	17 20 20	196 50 15	0		P.	36·85	0 56 20	36·73	0 55 30
„ 24	11 20	+1·52	+1·64	17 19 42	196 50 47	0		V.	36·69	0 55 13		
JULY 1	11 8	+1·50	+1·66	17 18 40	196 50 25	0		P.	36·58	0 54 30		
„ 8	11 21	+1·52	+1·66	17 18 5	196 48 57	0		V.	36·73	0 55 24		
„ 15	11 10	+1·54	+1·56	17 20 00	196 49 55	0		C.	36·89	0 56 30	36·81	0 56 0
„ 22	11 14	+1·55	+1·65	17 20 22	196 49 42	0		V.	36·95	0 56 59		
„ 29	11 10	+1·56	+1·65	17 19 57	196 49 40	0		P.	36·91	0 56 37		
AUG. 5	11 11	+1·51	+1·71	17 18 20	196 49 35	17E	0·52	V.	36·61	0 54 43		
„ 12	11 20	+1·57	+1·64	17 18 40	196 49 15	0		P.	36·80	0 55 47		
„ 20	11 32	+1·51	+1·71	17 18 50	196 49 12	0		V.	36·80	0 55 50	36·67	0 55 5
„ 26	11 31	+1·62	+1·61	17 16 20	196 48 45	0		P.	36·49	0 54 1		
SEPT. 2	11 12	+1·55	+1·69	17 18 17	196 48 25	0		V.	36·82	0 56 8		
„ 9	11 25	+1·57	+1·64	17 19 20	196 49 15	15E	0·68	P.	36·86	0 56 11		
„ 16	11 13	+1·49	+1·71	17 17 50	196 48 47	0		V.	36·69	0 55 14	36·80	0 55 50
„ 23	11 25	+1·51	+1·67	17 19 40	196 50 5	0		P.	36·82	0 55 50		
„ 30	11 23	+1·54	+1·69	17 19 20	196 49 50	0		V.	36·79	0 55 46		
OCT. 7	11 12	+1·57	+1·66	17 19 52	196 49 50	0		P.	36·91	0 56 22		
„ 14	10 40	+1·57	+1·71	17 19 2	196 48 47	0		V.	36·91	0 56 31		
„ 21	11 17	+1·52	+1·67	17 19 20	196 49 40	0		P.	36·81	0 55 56	36·87	0 56 15
„ 28	11 32	+1·52	+1·66	17 18 40	196 48 45	0		V.	36·86	0 56 11		
NOV. 4	11 0	+1·57	+1·60	17 20 10	196 50 00	0		P.	36·88	0 56 35		
„ 11	11 18	+1·52	+1·66	17 19 32	196 49 17	0		V.	36·89	0 56 31		
„ 18	11 18	+1·55	+1·59	17 19 40	196 49 40	0		P.	36·91	0 56 23	36·95	0 56 50
„ 25	11 29	+1·54	+1·60	17 20 25	196 48 55	0		V.	37·11	0 57 52		
DEC. 2	11 24	+1·55	+1·60	17 20 20	196 49 10	0		P.	37·09	0 57 33		
„ 9	11 28	+1·46	+1·74	17 19 12	196 49 7	20W	0·77	V.	36·94	0 56 36		
„ 16	11 15	+1·52	+1·62	17 19 40	196 49 35	0		P.	36·93	0 56 24	36·99	0 56 47
„ 23	11 34	+1·57	+1·57	17 21 27	196 51 25	0		V.	36·97	0 56 28		
„ 30	11 40	+1·55	+1·67	17 21 27	196 50 52	0		V.	37·04	0 56 53		

The Mean Declination for the year 1880 = ° 0 56 ′ 21 ″

Absolute Magnetical Observations.—Table VI.

OBSERVATIONS OF INCLINATION, 1880.

Taken with Barrow's Dip Circle, with Microscopes, No. 49, and a 3½-inch Needle, No. 5 by Adie.

1880. Date.	Bombay Civil Time (0 to 24 hours). At commencement.	At conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JAN. 2	15 5	16 14	C.	5	19 18·7	19 26·7	19 13·1	19 33·7	19 23·0	
„ 6	11 17	12 31	V.	5	19 26·3	19 27·7	19 23·6	19 25·3	19 25·7	
„ 9	14 50	16 5	V.	5	18 59·3	19 21·9	19 31·1	19 39·7	19 23·0	
„ 12	11 15	12 47	V.N.	5	20 0·9	20 2·8	18 33·1	18 36·1	19 18·2	
„ 16	15 4	16 36	P.	5	19 3·1	19 14·3	19 28·6	19 30·9	19 19·2	19 21·8
„ 20	11 10	12 38	V.	5	19 13·3	19 33·7	19 13·7	19 21·9	19 20·6	
„ 23	15 10	16 34	V.	5	19 24·6	19 31·2	19 15·2	19 13·2	19 21·0	
„ 27	11 6	12 16	P.	5	19 20·7	19 28·5	19 23·1	19 18·0	19 22·5	
„ 30	15 5	16 17	P.	5	19 32·0	19 16·1	19 19·6	19 25·5	19 23·2	
FEB. 3	11 4	12 28	V.	5	19 5·7	19 11·0	19 28·2	19 54·3	19 24·7	
„ 6	15 4	16 23	V.	5	19 7·2	19 12·1	19 46·9	19 31·9	19 24·5	
„ 10	10 59	12 6	P.	5	19 25·5	19 23·4	19 18·9	19 25·0	19 23·1	
„ 13	15 7	16 18	P.	5	19 15·9	19 20·9	19 22·0	19 32·5	19 22·8	19 22·1
„ 17	11 0	12 23	C.	5	19 16·3	19 11·7	19 20·0	19 32·3	10 20·0	
„ 20	15 9	16 14	C.	5	19 11·6	19 20·7	19 17·0	19 27·3	19 19·1	
„ 24	10 55	12 9	P.	5	19 17·7	19 20·4	19 15·6	19 27·7	19 20·3	
„ 27	15 6	16 18	P.	5	19 15·6	19 28·5	19 23·1	19 22·1	19 22·3	
MARCH 2	10 58	12 2	C.	5	19 18·7	19 9·6	19 28·7	19 27·7	19 21·1	
„ 5	15 4	16 10	C.	5	19 6·3	19 9·1	19 26·1	19 33·9	19 18·8	
„ 8	10 55	12 8	P.	5	19 13·5	19 15·1	19 13·9	19 30·1	19 18·1	
„ 12	15 0	16 10	P.	5	19 11·1	19 19·7	19 21·4	19 31·7	19 20·9	
„ 16	10 56	12 3	C.	5	19 18·2	19 14·4	19 20·4	19 33·1	19 21·5	19 20·2
„ 19	15 4	16 12	C.	5	19 9·8	19 12·4	19 21·9	19 30·9	19 18·7	
„ 23	10 58	12 10	P.	5	19 13·3	19 17·9	19 14·3	19 31·9	19 19·3	
„ 26	15 3	16 15	P.	5	19 12·3	19 16·7	19 23·6	19 38·6	19 22·8	
„ 30	10 58	12 2	C.	5	19 11·7	19 16·9	19 25·4	19 29·0	19 20·7	
APRIL 2	15 4	16 10	C.	5	19 13·6	19 19·1	19 14·6	19 31·4	19 19·7	
„ 6	11 0	12 10	P.	5	19 3·9	19 15·9	19 22·7	19 37·9	19 20·1	
„ 9	15 2	16 15	P.	5	19 9·6	19 17·4	19 25·9	19 35·8	19 22·2	
„ 13	10 57	12 4	C.	5	19 9·9	19 16·6	19 22·6	19 30·3	19 19·8	
„ 16	15 7	16 8	C.	5	19 11·5	19 24·9	19 16·3	19 27·6	19 20·1	19 20·7
„ 20	10 50	11 55	P.	5	19 16·1	19 22·9	19 12·4	19 25·5	19 19·2	
„ 23	15 3	16 13	P.	5	19 15·9	19 24·4	19 13·2	19 29·9	19 20·8	
„ 27	11 2	12 26	V.	5	19 26·2	19 12·1	19 25·6	19 28·1	19 23·0	
„ 30	15 10	16 29	V.	5	19 9·4	19 22·0	19 24·5	19 30·7	19 21·6	
MAY 4	10 48	12 1	P.	5	19 11·9	19 22·1	19 21·7	19 34·1	19 22·4	
„ 7	15 10	16 20	P.	5	19 13·1	19 30·4	19 19·4	19 31·2	19 23·5	
„ 11	10 52	12 10	V.	5	19 7·1	19 18·9	19 30·4	19 34·1	19 22·6	
„ 14	15 10	16 29	V.	5	19 8·5	19 19·4	19 29·7	19 40·7	19 24·6	19 23·4
„ 18	10 49	11 58	P.	5	19 10·4	19 20·0	19 27·1	19 37·9	19 23·8	
„ 21	15 4	16 20	P.	5	19 16·3	19 21·1	19 18·6	19 38·4	19 23·6	
„ 25	10 56	12 12	V.	5	19 1·7	19 20·6	19 24·4	19 40·7	19 21·8	
„ 28	15 7	16 33	V.	5	19 12·0	19 19·6	19 30·4	19 37·2	19 24·8	
JUNE 1	11 4	12 13	V.	5	19 4·4	19 18·3	19 32·1	19 32·9	19 21·9	
„ 4	15 5	16 17	P.	5	19 15·2	19 21·9	19 22·1	19 38·0	19 24·3	
„ 8	11 10	12 27	V.	5	19 8·7	19 17·2	19 29·6	19 31·3	19 21·7	
„ 11	15 5	16 29	V.	5	19 21·7	19 25·7	19 17·1	19 27·1	19 22·9	
„ 15	10 56	12 8	P.	5	19 14·9	19 25·9	19 18·1	19 33·1	19 23·0	19 22·7
„ 18	15 10	16 22	P.	5	19 16·7	19 17·8	19 18·4	19 35·4	19 22·1	
„ 22	10 58	12 14	V.	5	19 28·9	19 36·5	19 0·2	19 27·7	19 23·3	
„ 25	15 15	16 35	V.	5	19 6·4	19 37·7	19 20·2	19 24·6	19 22·2	
„ 29	10 53	12 8	P.	5	19 8·9	19 30·1	19 24·1	19 29·3	19 23·1	

1880. Date.	Bombay Civil Time (0 to 24 hours). At commencement.	At conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JULY 2	15 5	16 25	P.	5	19 4·3	19 27·5	19 26·5	19 33·1	19 22·8	
„ 6	11 12	12 27	V.	5	19 26·0	19 33·4	19 16·9	19 20·7	19 24·2	
„ 9	15 7	16 31	V.	5	19 26·5	19 44·2	19 7·3	19 14·6	19 23·1	
„ 13	11 0	12 12	P.	5	19 18·1	19 33·4	19 15·2	19 22·3	19 22·2	
„ 16	15 5	16 21	O.	5	19 24·6	19 33·5	19 6·3	19 23·6	19 22·0	19 22·6
„ 20	11 6	12 43	V.	5	19 25·9	19 42·6	19 1·8	19 11·7	19 20·5	
„ 23	15 10	16 29	V.	5	19 31·1	19 47·6	18 58·9	19 9·9	19 21·9	
„ 27	10 52	12 6	P.	5	19 26·7	19 27·6	19 15·1	19 22·7	19 23·0	
„ 30	15 6	16 16	P.	5	19 24·2	19 27·1	19 16·1	19 27·3	19 23·7	
AUG. 3	11 9	12 31	V.	5	19 42·6	19 51·9	19 7·3	18 45·1	19 21·7	
„ 6	15 15	16 31	V.	5	19 37·6	19 43·3	19 8·7	18 51·4	19 20·2	
„ 10	10 56	12 10	P.	5	19 36·0	19 38·1	19 14·6	19 1·9	19 22·6	
„ 13	15 11	16 23	P.	5	19 22·9	19 36·6	19 15·4	19 14·2	19 22·3	
„ 17	12 15	13 42	V.	5	19 40·8	19 44·4	18 59·2	18 58·5	19 20·7	19 21·3
„ 20	15 17	16 39	V.	5	19 44·4	19 49·2	19 0·7	18 50·8	19 21·3	
„ 24	10 54	12 8	P.	5	19 22·6	19 35·1	19 7·3	19 16·9	19 20·5	
„ 28	15 8	16 27	P.	5	19 32·7	19 28·8	19 13·4	19 8·4	19 20·8	
„ 31	11 12	12 37	V.	5	19 39·5	19 49·7	18 59·2	18 56·8	19 21·3	
SEPT. 3	15 4	16 26	V.	5	19 34·5	19 56·9	18 57·4	18 55·4	19 21·0	
„ 7	10 50	12 1	P.	5	19 33·9	19 47·8	19 3·5	19 11·9	19 24·3	
„ 10	15 10	16 20	P.	5	19 30·1	19 44·9	19 3·9	19 11·8	19 22·7	
„ 14	11 12	12 31	V.	5	19 52·6	19 54·7	18 56·5	18 50·0	19 23·4	19 22·6
„ 17	15 10	16 36	V.	5	19 59·9	19 55·4	18 50·1	18 42·9	19 22·1	
„ 21	10 55	12 5	P.	5	19 39·4	19 41·4	19 4·3	19 1·3	19 21·6	
„ 24	15 4	16 19	P.	5	19 25·1	19 51·2	19 6·6	19 9·4	19 23·1	
„ 28	11 10	12 36	V.	5	20 9·4	19 51·3	18 47·2	18 43·4	19 22·8	
OCT. 1	15 11	16 37	V.	5	20 1·8	20 1·3	18 49·4	18 35·2	19 21·9	
„ 5	10 55	12 16	P.	5	19 41·4	19 57·7	18 59·4	18 57·2	19 23·9	
„ 8	15 8	16 24	P.	5	19 33·1	19 54·1	18 59·6	18 56·9	19 20·9	
„ 12	11 11	12 35	V.	5	19 43·6	20 22·1	18 27·6	18 48·7	19 20·5	
„ 15	15 30	16 35	P.	5	19 38·9	19 54·2	18 48·6	18 59·4	19 20·3	19 20·6
„ 19	11 0	12 6	P.	5	19 45·2	19 58·9	18 41·2	18 49·4	19 18·7	
„ 22	15 6	16 25	P.	5	19 39·9	19 59·2	18 52·4	18 47·9	19 19·8	
„ 26	11 12	12 35	V.	5	19 44·1	20 21·1	18 40·6	18 34·5	19 20·1	
„ 29	15 11	16 34	V.	5	19 43·1	20 13·9	18 39·4	18 41·4	19 19·4	
NOV. 2	10 59	12 9	P.	5	19 41·5	19 56·7	18 48·9	18 46·9	19 18·5	
„ 5	15 6	16 18	P.	5	19 37·1	20 1·5	18 48·7	18 46·4	19 18·4	
„ 9	11 14	12 23	V.	5	19 42·0	20 13·8	18 41·2	18 38·4	19 18·8	
„ 12	15 12	16 34	V.	5	19 42·3	20 14·9	18 37·4	18 45·6	19 20·0	
„ 16	10 55	12 13	P.	5	19 34·2	20 4·4	18 48·2	18 56·9	19 20·9	19 20·6
„ 19	15 4	16 24	P.	5	19 44·9	19 47·5	19 0·1	18 59·7	19 23·0	
„ 23	11 9	12 29	V.	5	20 6·9	19 42·6	18 58·4	18 36·0	19 21·0	
„ 26	15 7	16 26	V.	5	19 38·2	20 20·2	18 29·1	18 50·0	19 19·4	
„ 30	10 55	12 10	P.	5	19 47·2	20 10·6	18 32·6	19 12·1	19 25·6	
DEC. 3	15 1	16 12	P.	5	19 33·6	20 19·4	18 31·3	18 57·9	19 20·5	
„ 7	11 10	12 27	V.	5	20 21·2	19 38·1	19 3·9	18 18·3	19 20·4	
„ 10	15 11	16 33	V.	5	20 13·0	19 40·5	19 11·4	18 14·3	19 19·8	
„ 14	10 48	12 1	P.	5	19 48·9	19 45·2	19 15·7	18 36·1	19 21·5	
„ 17	15 5	16 16	P.	5	19 38·5	19 56·9	19 19·7	18 29·2	19 21·1	19 20·2
„ 21	11 12	12 34	V.	5	20 10·0	19 48·8	18 59·2	18 15·6	19 18·4	
„ 24	15 2	16 12	O.	5	20 2·1	19 45·7	19 1·4	18 47·6	19 24·2	
„ 28	11 15	12 45	V.N.	5	19 47·7	18 42·5	19 10·7	19 21·3	19 15·5	
„ 31	14 37	15 58	V.	5	19 34·7	19 31·4	19 20·6	18 53·2	19 20·0	

The Mean Dip for the year 1880 = ° 19 21·6

Absolute Magnetical Observations.—Table VII.

Observations of Vibration and Deflection, taken with the Kew Unifilar Magnetometer (No. 23, by Elliott Brothers), for the determination of Absolute Horizontal Force.

1881.

1881. Date.	Civil Time Mean.	Magnet N. 23 *a*. Time of one Vibration *b*.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 *c* by N. 23 *a* at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance. 0·8 foot ($X_{0·8}$)	1·0 foot ($X_{1·0}$)	Difference. $X_{0·8}-X_{1·0}$	Mean. $\frac{X_{0·8}+X_{1·0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
JAN. 5	12 12	2·8038	0·78	81·5	+7·9	15·00	77·9	18 0 1	9 8 35	82·0	14·82	78·4	V.	·65452	8·1087	8·1076	+·0011	8·1081		
„ „	15 1	2·8047	0·77	82·4	„	14·31	80·6	18 0 10	9 8 44	82·9	14·49	80·0	V.	·65467	8·1053	8·1020	+·0033	8·1036		
„ 13	12 25	2·8048	0·74	85·7	+6·7	14·58	80·2	18 0 2	9 8 32	85·3	14·44	80·6	P.	·65483	8·1062	8·1057	+·0005	8·1059		
„ „	14 56	2·8053	0·77	86·6	„	14·13	81·6	18 0 15	9 8 37	86·7	14·26	81·1	P.	·65498	8·1035	8·1029	+·0006	8·1032		
„ 19	12 11	2·8046	0·86	85·7	+8·4	15·17	79·8	17 58 26	9 7 49	86·0	15·05	80·4	V.	·65449	8·1119	8·1105	+·0014	8·1112	8·1057	3·7374
„ „	15 4	2·8067	0·89	87·8	„	14·32	82·8	17 58 31	9 7 52	88·5	14·69	81·5	V.	·65444	8·1048	8·1036	+·0012	8·1042		
„ 26	12 17	2·8048	0·85	86·8	+8·6	14·17	81·4	17 59 40	9 8 30	85·9	14·06	81·7	P.	·65489	8·1079	8·1062	+·0017	8·1070		
„ „	14 53	2·8064	0·85	87·9	„	13·92	82·6	17 59 47	9 8 30	86·5	14·04	82·1	P.	·65471	8·1033	8·1020	+·0013	8·1026		
FEB. 2	12 10	2·8057	0·81	84·0	+8·0	14·05	80·1	18 0 42	9 8 54	84·0	13·92	80·4	C.	·65461	8·1010	8·1001	+·0009	8·1005		
„ „	14 57	2·8068	0·83	83·0	„	13·37	81·0	18 1 20	9 9 15	83·9	13·59	81·0	C.	·65461	8·0947	8·0934	+·0013	8·0940		
„ 9	12 45	2·8048	0·81	87·4	+8·1	14·83	82·0	17 57 40	9 7 22	86·6	14·67	82·2	P.	·65432	8·1150	8·1143	+·0007	8·1146		
„ „	14 58	2·8058	0·86	88·5	„	13·81	83·0	17 57 47	9 7 27	87·5	14·21	82·6	P.	·65449	8·1117	8·1107	+·0010	8·1112	8·1047	3·7369
„ 16	12 34	2·8071	0·69	85·5	+6·5	14·10	82·1	17 59 45	9 7 31	86·0	13·77	82·6	V. N.	·65390	8·0997	8·1055	−·0058	8·1026		
„ „	15 25	2·8073	0·62	83·7	„	13·38	83·6	17 58 49	9 7 27	86·2	13·45	83·2	V. N.	·65372	8·1010	8·1038	−·0028	8·1024		
„ 23	12 12	2·8058	0·73	86·2	+6·7	14·76	81·4	17 58 35	9 7 47	85·4	14·67	81·7	P.	·65420	8·1089	8·1083	+·0006	8·1086		
„ „	14 50	2·8070	0·76	85·7	„	13·94	83·0	17 58 52	9 7 55	85·7	14·25	82·7	P.	·65415	8·1036	8·1033	+·0003	8·1034		
MAR. 2	12 48	2·8061	0·64	87·4	+5·1	14·31	83·5	17 58 21	9 7 49	86·5	14·10	83·9	V.	·65423	8·1089	8·1074	+·0015	8·1081		
„ „	15 20	2·8075	0·63	86·4	„	13·43	84·7	17 59 26	9 8 26	87·9	13·53	84·2	V.	·65436	8·0988	8·0967	+·0021	8·0977		
„ 9	12 13	2·8048	0·66	85·1	+7·0	14·70	81·8	17 58 45	9 8 7	84·0	14·51	82·0	P.	·65435	8·1117	8·1094	+·0023	8·1105		
„ „	14 54	2·8065	0·64	85·8	„	13·83	83·0	17 59 20	9 8 30	85·1	14·08	82·5	P.	·65446	8·1044	8·1014	+·0030	8·1029		
„ 17	12 29	2·8043	0·66	87·5	+6·7	15·07	83·0	17 57 40	9 7 34	86·9	14·69	83·3	V.	·65477	8·1165	8·1143	+·0022	8·1154	8·1066	3·7378
„ „	15 21	2·8067	0·64	86·4	„	13·78	84·0	17 58 14	9 7 57	87·9	14·07	83·9	V.	·65436	8·1055	8·1025	+·0030	8·1040		
„ 23	11 57	2·8055	0·65	86·2	+5·7	14·52	83·7	17 58 27	9 7 55	85·2	14·34	84·0	C.	·65438	8·1105	8·1087	+·0018	8·1096		
„ „	14 42	2·8067	0·65	83·7	„	13·73	84·2	17 58 50	9 8 1	84·9	13·92	84·2	C.	·65402	8·1036	8·1025	+·0011	8·1030		
„ 30	12 8	2·8062	0·60	88·8	+5·7	14·49	84·9	17 57 26	9 7 26	88·8	14·24	85·1	V.	·65420	8·1113	8·1092	+·0021	8·1102		
„ „	15 2	2·8072	0·75	88·4	„	13·77	86·0	17 57 51	9 7 33	89·7	13·94	85·6	V.	·65424	8·1053	8·1040	+·0013	8·1046		

b. Uncorrected for rate of Chronometer.

1881. Date.		Civil Time. Mean.	Magnet N. 23 *a*. Time of one Vibration *b*.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 *c* by N. 23 *a* at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance. 0·8 foot ($X_{0\cdot8}$)	1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8} - X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1		2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		h. m	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
April	6	12 15	2·8062	0·65	87·4	+5·5	14·62	85·1	17 57 55	9 7 40	87·3	14·34	85·6	P.	·65414	8·1094	8·1076	+·0018	8·1085		
„	„	15 13	2·8069	0·64	87·6	„	13·51	86·7	17 58 20	9 7 57	87·6	13·78	86·5	P.	·65438	8·1059	8·1033	+·0026	8·1046		
„	13	12 9	2·8073	0·58	88·4	+4·7	14·56	84·6	17 57 0	9 7 5	88·4	14·46	85·2	V.N.	·65381	8·1096	8·1085	+·0011	8·1090		
„	„	15 22	2·8082	0·59	88·4	„	13·39	86·8	17 56 52	9 7 10	89·9	13·91	86·2	V.N.	·65394	8·1061	8·1038	+·0023	8·1049		
„	20	12 9	2·8077	0·58	90·5	+3·5	13·97	85·5	17 57 32	9 7 20	90·0	13·90	85·9	P.	·65414	8·1066	8·1057	+·0009	8·1061	8·1054	3·7372
„	„	14 53	2·8080	0·60	90·3	„	13·56	87·1	17 57 47	9 7 32	90·2	13·86	86·8	P.	·65427	8·1044	8·1029	+·0015	8·1036		
„	27	12 19	2·8081	0·55	90·4	+4·0	13·60	87·0	17 57 6	9 7 14	90·4	13·47	87·2	V.	·65393	8·1068	8·1049	+·0019	8·1058		
„	„	15 9	2·8088	0·48	89·0	„	13·06	88·1	17 57 17	9 7 21	91·6	13·18	88·0	V.	·65394	8·1020	8·1001	+·0019	8·1010		
May	4	12 8	2·8074	0·62	91·6	+4·2	13·98	87·3	17 56 47	9 7 0	91·4	13·82	87·9	P.	·65415	8·1100	8·1089	+·0011	8·1094		
„	„	14 57	2·8085	0·58	91·2	„	13·05	89·2	17 57 2	9 7 7	91·3	13·27	88·8	P.	·65406	8·1057	8·1046	+·0011	8·1051		
„	11	12 5	2·8081	0·51	92·0	+3·8	13·76	88·2	17 55 54	9 6 38	91·7	13·54	88·7	V.	·65376	8·1115	8·1096	+·0019	8·1105		
„	„	14 50	2·8095	0·49	92·1	„	12·92	89·4	17 56 50	9 7 8	92·9	12·90	89·1	V.	·65387	8·1029	8·1010	+·0019	8·1019	8·1076	3·7383
„	18	12 7	2·8080	0·52	92·6	+4·7	13·63	88·2	17 55 32	9 6 27	93·4	13·50	88·7	P.	·65390	8·1119	8·1102	+·0017	8·1110		
„	„	14 51	2·8094	0·52	92·3	„	12·87	90·1	17 55 47	9 6 32	93·5	13·06	89·6	P.	·65370	8·1066	8·1053	+·0013	8·1059		
„	25	12 14	2·8085	0·55	92·0	+3·8	13·73	89·1	17 55 20	9 6 7	92·9	13·61	89·6	V.	·65358	8·1111	8·1111	·0000	8·1111		
„	„	15 14	2·8098	0·58	92·8	„	12·93	90·7	17 55 23	9 6 12	94·7	13·35	90·4	V.	·65369	8·1061	8·1055	+·0006	8·1058		
June	1	12 53	2·8096	0·56	92·6	+3·6	13·63	89·2	17 55 25	9 6 7	92·6	13·48	89·6	P.	·65333	8·1083	8·1087	−·0004	8·1085		
„	„	15 14	2·8101	0·53	92·5	„	12·95	90·1	17 55 43	9 6 22	92·8	13·07	90·0	P.	·65343	8·1057	8·1051	+·0006	8·1054		
„	8	12 26	2·8095	0·49	87·4	+3·8	13·16	87·0	17 57 45	9 7 35	87·3	13·02	87·5	V.	·65340	8·1007	8·0986	+·0021	8·0996		
„	„	15 22	2·8099	0·49	86·7	„	12·64	88·0	17 58 4	9 7 41	87·9	12·70	87·9	V.	·65343	8·0973	8·0956	+·0017	8·0964		
„	15	12 10	2·8082	0·54	90·1	+3·1	14·20	86·2	17 56 37	9 6 50	89·7	13·81	86·5	P.	·65351	8·1085	8·1079	+·0006	8·1082		
„	„	14 59	2·8090	0·51	90·4	„	13·23	87·0	17 56 50	9 6 57	89·4	13·38	86·9	P.	·65364	8·1061	8·1053	+·0008	8·1057	8·1078	3·7383
„	22	12 3	2·8085	0·47	92·6	+4·2	13·95	87·6	17 54 58	9 5 57	92·6	13·88	87·9	V.	·65352	8·1133	8·1133	·0000	8·1133		
„	„	15 12	2·8101	0·50	92·1	„	13·22	88·8	17 54 52	9 6 1	93·6	13·61	88·4	V.	·65336	8·1077	8·1068	+·0009	8·1072		
„	29	12 8	2·8054	0·51	87·6	+2·5	14·53	85·2	17 55 52	9 6 27	87·9	14·45	85·5	P.	·65381	8·1190	8·1184	+·0006	8·1187		
„	„	14 54	2·8063	0·49	88·1	„	13·87	86·1	17 56 7	9 6 37	88·1	14·24	85·9	P.	·65391	8·1158	8·1148	+·0010	8·1153		
July	6	12 12	2·8064	0·42	83·9	+0·4	14·24	83·0	17 57 35	9 7 12	84·8	14·11	83·1	V.	·65351	8·1094	8·1096	−·0002	8·1095		
„	„	15 9	2·8093	0·43	86·2	„	13·47	84·3	17 57 31	9 7 16	86·5	13·77	83·8	V.	·65330	8·1016	8·1010	+·0006	8·1013		
„	13	12 12	2·8074	0·47	86·1	+0·4	13·56	83·0	17 57 52	9 7 22	85·2	13·47	83·3	P.	·65358	8·1070	8·1070	·0000	8·1070		
„	„	15 0	2·8076	0·44	86·0	„	13·11	84·0	17 58 10	9 7 27	86·1	13·33	83·9	P.	·65379	8·1042	8·1048	−·0006	8·1045		
„	20	12 8	2·8072	0·37	88·1	+1·3	14·34	84·1	17 55 28	9 6 12	88·7	14·30	84·6	V.	·65339	8·1150	8·1148	+·0002	8·1149	8·1092	3·7390
„	„	14 58	2·8090	0·37	87·8	„	13·63	85·8	17 55 48	9 6 26	88·7	14·05	85·2	V.	·65321	8·1083	8·1077	+·0006	8·1080		
„	27	12 8	2·8067	0·35	86·5	+1·0	14·76	83·3	17 55 15	9 6 3	86·2	14·69	83·7	V.	·65310	8·1180	8·1182	−·0002	8·1181		
„	„	15 6	2·8085	0·36	87·0	„	13·96	84·8	17 55 35	9 6 25	87·3	14·31	84·4	V.	·65312	8·1111	8·1098	+·0013	8·1104		

Aug.	3	12	12	2·8065	0·46	82·2	+0·6	14·81	82·0	17	56	17	9	6	27	82·1	14·78	82·1	P.	·65280	8·1148	8·1158	−·0010	8·1153		
„	„	14	54	2·8072	0·46	81·9	„	14·18	82·1	17	56	17	9	6	32	82·1	14·45	82·1	P.	·65278	8·1126	8·1130	−·0004	8·1128		
„	10	12	14	2·8082	0·35	86·7	0·0	14·20	83·0	17	57	58	9	7	21	82·2	14·04	83·3	V.	·65319	8·1076	8·1081	−·0005	8·1078		
„	„	15	20	2·8085	0·38	84·9	0·0	13·68	83·0	17	57	59	9	7	26	82·3	13·85	83·0	V.	·65318	8·1051	8·1051	·0000	8·1051		
„	17	12	12	2·8077	0·37	84·8	−0·2	14·18	82·8	17	57	22	9	7	5	84·4	14·11	82·9	V.	·65321	8·1076	8·1079	−·0003	8·1077		
„	„	15	19	2·8089	0·37	83·4	„	13·44	83·5	17	57	26	9	7	11	84·8	13·76	83·3	V.	·65306	8·1021	8·1020	+·0001	8·1020	8·1087	3·7388
„	24	12	14	2·8075	0·43	84·8	−0·8	14·18	82·2	17	56	50	9	6	47	85·0	14·14	82·7	P.	·65318	8·1094	8·1100	−·0006	8·1097		
„	„	15	1	2·8087	0·41	84·6	„	13·78	83·9	17	57	17	9	7	0	85·6	13·87	83·8	P.	·65306	8·1035	8·1040	−·0005	8·1037		
„	31	12	14	2·8074	0·43	85·1	+1·3	14·31	84·0	17	55	30	9	6	21	86·1	14·22	84·0	V.	·65294	8·1141	8·1130	+·0011	8·1135		
„	„	15	15	2·8085	0·46	87·2	„	13·71	85·0	17	56	2	9	6	30	87·5	13·97	84·7	V.	·65319	8·1092	8·1090	+·0002	8·1091		
Sept.	7	12	30	2·8082	0·47	87·8	+1·6	14·25	84·0	17	55	37	9	6	23	87·5	14·09	84·2	V.	·65303	8·1122	8·1113	+·0009	8·1117		
„	„	15	23	2·8091	0·50	87·6	„	13·57	85·0	17	56	1	9	6	38	88·4	13·78	84·9	V.	·65315	8·1070	8·1057	+·0013	8·1063		
„	14	12	10	2·8101	0·51	85·7	+1·1	13·08	82·7	17	58	25	9	7	37	85·6	12·96	83·2	P.	·65310	8·0964	8·0965	−·0001	8·0964		
„	„	14	57	2·8101	0·49	86·8	„	12·70	84·1	17	58	45	9	7	45	85·9	12·68	83·9	P.	·65330	8·0958	8·0964	−·0006	8·0961		
„	21	12	20	2·8084	0·49	88·6	+1·3	13·63	84·3	17	56	55	9	6	55	87·8	13·60	84·8	P.	·65349	8·1072	8·1072	·0000	8·1072	8·1044	3·7368
„	„	15	4	2·8091	0·47	87·7	„	13·12	85·3	17	57	12	9	7	2	88·1	13·35	85·1	P.	·65343	8·1033	8·1033	·0000	8·1033		
„	28	12	16	2·8078	0·49	84·6	+1·7	14·27	83·0	17	56	43	9	6	53	84·8	14·12	83·3	V.	·65301	8·1090	8·1083	+·0007	8·1086		
„	„	15	16	2·8087	0·45	85·5	„	13·59	84·0	17	56	51	9	7	0	85·5	13·94	83·9	V.	·65321	8·1061	8·1051	+·0010	0·1056		
Oct.	5	12	11	2·8080	0·49	87·7	−0·2	14·22	83·9	17	56	17	9	6	35	87·0	14·02	84·4	P.	·65318	8·1105	8·1105	·0000	8·1105		
„	„	14	58	2·8087	0·46	87·5	„	13·29	85·3	17	56	40	9	6	52	87·3	13·49	85·2	P.	·65331	8·1066	8·1061	+·0005	8·1063		
„	12	12	11	2·8086	0·54	87·4	+1·0	14·31	83·6	17	55	21	9	6	15	86·9	14·13	83·9	V.	·65277	8·1120	8·1111	+·0009	8·1115		
„	„	15	17	2·8098	0·50	86·0	„	13·41	84·9	17	55	58	9	6	42	86·9	13·66	84·6	V.	·65277	8·1051	8·1031	+·0020	8·1041		
„	19	12	12	2·8095	0·56	88·2	+2·5	13·52	84·0	17	56	12	9	6	40	87·5	13·50	84·1	P.	·65298	8·1064	8·1055	+·0009	8·1059	8·1064	3·7377
„	„	15	1	2·8099	0·53	87·2	„	12·98	84·9	17	56	32	9	6	47	87·7	13·78	84·6	P.	·65300	8·1033	8·1027	+·0006	8·1030		
„	26	12	22	2·8097	0·56	89·1	+3·3	14·09	84·6	17	55	38	9	6	30	89·0	13·78	85·3	V.	·65287	8·1076	8·1059	+·0017	8·1067		
„	„	15	17	2·8103	0·53	87·3	„	13·05	87·0	17	55	40	9	6	24	89·9	13·35	86·4	V.	·65287	8·1035	8·1025	+·0010	8·1030		
Nov.	2	12	15	2·8100	0·53	89·8	+6·6	14·00	83·7	17	55	10	9	6	5	89·9	13·98	83·9	P.	·65360	8·1083	8·1079	+·0004	8·1081		
„	„	15	1	2·8102	0·52	89·4	„	13·55	84·2	17	55	12	9	6	7	90·4	13·79	84·1	P.	·65294	8·1070	8·1064	+·0006	8·1067		
„	9	12	25	2·8094	0·66	89·0	+5·8	14·17	84·0	17	58	47	9	7	47	89·9	12·04	84·9	V.	·65297	8·0962	8·0965	−·0003	8·0963		
„	„	15	31	2·8178	0·60	86·2	„	10·16	86·5	18	0	46	9	8	52	88·6	10·96	85·9	V.	·65268	8·0638	8·0632	+·0006	8·0635		
„	16	12	15	2·8097	0·67	88·8	+4·7	13·73	87·0	17	55	15	9	6	7	90·0	13·47	87·3	P.	·65274	8·1077	8·1074	+·0003	8·1075	8·1000	3·7346
„	„	15	0	2·8103	0·72	89·8	„	12·82	88·0	17	55	46	9	6	21	90·4	13·07	87·7	P.	·65306	8·1046	8·1044	+·0002	8·1045		
„	23	12	16	2·8083	0·78	85·1	+8·0	15·25	80·4	17	55	39	9	6	20	86·3	14·95	80·7	V.	·65268	8·1107	8·1104	+·0003	8·1105		
„	„	15	18	2·8096	0·81	84·6	„	13·95	83·1	17	56	25	9	6	48	88·1	14·37	81·9	V.	·65295	8·1020	8·1010	+·0010	8·1015		
„	30	12	11	2·8099	0·82	86·5	+7·6	14·09	81·1	17	56	47	9	7	0	86·8	13·93	81·7	P.	·65287	8·1025	8·1012	+·0013	8·1018		
„	„	14	57	2·8107	0·81	87·6	„	13·38	83·0	17	57	7	9	7	7	86·9	13·65	82·5	P.	·65298	8·0999	8·0990	+·0009	8·0994		
Dec.	7	11	49	2·8100	0·80	86·4	+7·0	14·68	80·4	17	56	4	9	6	26	86·7	14·53	80·8	V.	·65254	8·1048	8·1051	−·0003	8·1049		
„	„	15	24	2·8106	0·78	84·9	„	14·19	83·0	17	55	47	9	6	26	87·6	14·44	82·1	V.	·65242	8·1020	8·1014	+·0006	8·1017		
„	14	12	33	2·8094	0·77	87·6	+6·4	14·53	82·0	17	56	7	9	6	37	87·5	14·34	82·4	P.	·65287	8·1066	8·1059	+·0007	8·1062		
„	„	14	58	2·8099	0·76	87·8	„	13·84	83·9	17	56	27	9	6	45	88·0	13·99	83·7	P.	·65301	8·1038	8·1033	+·0005	8·1035		
„	21	12	22	2·8097	0·90	86·5	+7·2	14·74	80·8	17	55	37	9	6	27	87·0	14·60	81·1	V.	·65257	8·1070	8·1055	+·0015	8·1062	8·1028	3·7360
„	„	15	20	2·8107	0·90	85·9	„	13·97	83·0	17	56	46	9	6	57	87·2	14·09	82·4	V.	·65269	8·0993	8·0984	+·0009	8·0988		
„	28	12	38	2·8102	0·90	82·3	+6·8	14·35	81·3	17	56	48	9	7	0	84·1	14·20	81·1	V. N.	·65223	8·1001	8·0990	+·0011	8·0995		
„	„	15	19	2·8108	0·86	83·9	„	14·16	81·8	17	56	26	9	6	53	83·0	14·22	81·3	V. N.	·65212	8·1023	8·1007	+·0016	8·1015		
The mean value of the Horizontal Force for the year 1881 =																							8·1058	3·7374

Absolute Magnetical Observations.—Table VIII.

Observations of Absolute Declination.

1881.

1881. Date.	Bombay Civil Time.	Mean Readings. Collimator Magnet. Scale apparently Erect.	Inverted.	Horizontal Circle with Telescope pointed to: Scale of Collimator Magnet.	Tárdeo Chimney.	Torsion. Mean.	Effect of 90°.	Observer.	Corresponding Reading of large Declination Magnetometer.	Absolute Easterly Declination corrected for Torsion.	Monthly Mean. Corresponding Reading of large Declination Magnetometer.	Absolute Easterly Declination.
1	2	3	4	5	6	7	8	9	10	11	12	13
	h. m.	Sc. div.	Sc. div.	° ′ ″	° ′ ″	°	Sc. div.		Sc. div.	° ′ ″	Sc. div.	° ′ ″
Jan. 6	11 11	+1·47	+1·64	17 20 12	196 51 2	0		V.	36·83	0 55 25		
„ 13	10 54	+1·52	+1·59	17 21 30	196 50 37	0		P.	37·09	0 57 15	36·94	0 56 10
„ 20	11 33	+1·52	+1·74	17 19 27	196 49 52	0		V.	36·90	0 55 46		
„ 27	11 25	+1·60	+1·72	17 20 15	196 50 5	10 E	0·76	P.	36·96	0 56 16		
Feb. 3	11 21	+1·59	+1·70	17 20 35	196 50 02	0		C.	37·04	0 56 52		
„ 10	11 11	+1·56	+1·62	17 20 20	196 50 20	0		P.	36·98	0 56 22	37·07	0 57 8
„ 17	11 54	+1·52	+1·57	17 24 00	196 52 35	0		V.N.	37·17	0 57 48		
„ 24	11 18	+1·54	+1·62	17 24 50	196 53 40	0		P.	37·11	0 57 30		
Mar. 3	11 18	+1·52	+1·59	17 22 27	196 51 40	0		V.	37·05	0 57 9		
„ 10	11 22	+1·52	+1·62	17 22 10	196 51 50	15 W	0·76	P.	37·04	0 56 56		
„ 17	10 58	+1·57	+1·62	17 21 37	196 50 50	0		V.	37·09	0 57 10	37·07	0 57 9
„ 24	11 11	+1·57	+1·59	17 22 5	196 51 00	0		C.	37·32	0 57 30		
„ 31	11 19	+1·51	+1·71	17 22 17	196 51 30	0		V.	37·07	0 56 59		
April 8	11 26	+1·52	+1·61	17 20 40	196 51 5	0		P.	36·89	0 55 55		
„ 14	11 21	+1·54	+1·59	17 21 2	196 51 17	0		C.	36·92	0 56 8	36·82	0 55 33
„ 21	11 24	+1·56	+1·62	17 21 30	196 51 50	0		P.	36·89	0 56 2		
„ 28	11 17	+1·60	+1·56	17 18 32	196 50 55	0		V.	36·58	0 54 6		
May 5	11 11	+1·56	+1·60	17 20 0	196 51 30	0		P.	36·69	0 54 53		
„ 12	11 22	+1·51	+1·71	17 19 10	196 50 32	0		V.	36·71	0 54 50	36·71	0 54 51
„ 19	11 17	+1·54	+1·66	17 20 00	196 50 40	0		P.	36·84	0 55 38		
„ 26	11 15	+1·61	+1·54	17 18 5	196 50 32	0		V.	36·62	0 54 3		
June 2	11 22	+1·54	+1·56	17 19 40	196 50 25	0		P.	36·88	0 55 40		
„ 9	11 32	+1·54	+1·72	17 20 2	196 50 55	0		V.	36·93	0 55 21		
„ 16	11 16	+1·57	+1·61	17 20 10	196 50 35	0		P.	36·79	0 55 58	36·72	0 54 59
„ 23	11 17	+1·52	+1·80	17 19 12	196 50 45	0		V.	36·61	0 54 34		
„ 30	11 20	+1·51	+1·72	17 18 40	196 51 30	0		P.	36·37	0 53 22		
July 7	11 14	+1·50	+1·74	17 19 22	196 49 57	0		V.	36·75	0 55 34		
„ 14	11 19	+1·50	+1·72	17 19 40	196 49 42	15 E	0·71	P.	36·77	0 55 54		
„ 21	11 24	+1·55	+1·69	17 20 7	196 49 57	0		V.	36·89	0 56 26	36·79	0 55 51
„ 28	11 16	+1·54	+1·62	17 19 27	196 50 17	0		V.	36·77	0 55 30		
Aug. 4	11 25	+1·50	+1·67	17 18 25	196 50 10	0		P.	36·61	0 54 30		
„ 11	11 12	+1·54	+1·65	17 17 2	196 49 27	0		V.	36·51	0 53 54	36·63	0 54 36
„ 18	11 35	+1·57	+1·69	17 18 27	196 49 30	0		V.	36·72	0 55 15		
„ 25	11 17	+1·50	+1·67	17 18 40	196 50 10	0		P.	36·67	0 54 45		
Sept. 1	11 8	+1·52	+1·76	17 19 35	196 50 2	0		V.	36·81	0 55 42		
„ 8	11 39	+1·55	+1·64	17 17 22	196 49 27	0		V.	36·61	0 54 15		
„ 15	11 13	+1·51	+1·64	17 20 00	196 50 15	0		P.	36·89	0 56 3	36·77	0 55 18
„ 22	11 15	+1·49	+1·70	17 20 20	196 49 45	0		P.	37·00	0 56 47		
„ 29	11 21	+1·52	+1·69	17 17 12	196 49 45	0		V.	36·54	0 53 42		
Oct. 6	11 10	+1·55	+1·67	17 18 55	196 49 40	0		P.	36·77	0 55 33		
„ 13	11 27	+1·51	+1·81	17 20 2	196 50 12	0		V.	36·84	0 55 55		
„ 20	11 24	+1·52	+1·60	17 20 5	196 49 55	0		P.	36·93	0 56 30	36·86	0 56 3
„ 27	11 26	+1·54	+1·67	17 19 5	196 49 10	0		V.	36·90	0 56 13		
Nov. 3	11 25	+1·52	+1·60	17 20 00	196 49 00	0		P.	37·09	0 57 20		
„ 10	11 13	+1·52	+1·75	17 18 50	196 49 32	0		V.	36·82	0 55 29		
„ 17	11 27	+1·57	+1·61	17 20 30	196 49 37	0		P.	37·05	0 57 16	36·95	0 56 43
„ 24	11 33	+1·51	+1·91	17 20 27	196 49 37	0		V.	36·83	0 56 48		
Dec. 1	11 14	+1·57	+1·62	17 20 25	196 50 30	0		P.	36·80	0 56 18		
„ 8	11 25	+1·60	+1·54	17 20 7	196 50 50	0		V.	36·72	0 55 47		
„ 15	11 31	+1·57	+1·62	17 22 10	196 50 50	0		P.	37·05	0 57 43	36·88	0 56 40
„ 22	11 17	+1·56	+1·57	17 21 27	196 51 30	0		V.	36·86	0 56 23		
„ 29	11 34	+1·52	+1·57	17 21 55	196 51 7	0		V.N.	36·96	0 57 11		

The Mean Declination for the year 1881 = ° ′ ″ 0 55 55

Absolute Magnetical Observations.—Table IX.

OBSERVATIONS OF INCLINATION, 1881.

Taken with Barrow's Dip Circle, with Microscopes, No. 49, and three 3½ inch Needles, viz. :—
with No. 5 by Adie, from January 4 to November 25.
„ No. 2 by John Dover, from October 7 to December 30.
and with No. ⅔ by „ „ „ „ 4 to „ 27.

Date.	Bombay Civil Time (0 to 24 hours.) At Commencement.	Bombay Civil Time (0 to 24 hours.) At Conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	End of Needle Dipping. A. Face of Circle. West.	End of Needle Dipping. B. Face of Circle. East.	End of Needle Dipping. B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JAN. 4	10 59	12 19	V.	5	19 57·9	19 52·6	18 55·5	18 48·0	19 23·5	
„ 7	15 4	16 32	V.	5	19 45·7	19 56·4	18 55·0	18 41·9	19 19·7	
„ 11	11 22	12 34	P.	5	19 43·2	19 42·1	19 17·9	18 49·1	19 23·1	
„ 14	15 12	16 28	P.	5	19 59·5	19 44·0	19 6·6	18 47·1	19 24·3	19 22·1
„ 18	10 54	12 31	V.	5	20 16·2	19 20·9	18 53·7	18 46·9	19 19·4	
„ 21	15 13	16 41	V.	5	20 17·1	19 33·5	19 8·6	18 34·7	19 23·5	
„ 25	10 55	12 9	P.	5	19 56·9	19 34·6	19 13·7	18 46·4	19 22·9	
„ 28	15 7	16 18	P.	5	20 5·5	19 37·4	18 59·5	18 40·8	19 20·8	
FEB. 1	11 4	12 14	C.	5	19 51·2	19 23·7	19 16·3	19 0·4	19 22·9	
„ 4	15 7	16 19	C.	5	19 30·4	19 25·1	18 57·2	19 34·6	19 21·8	
„ 8	11 0	12 9	P.	5	19 35·8	19 59·4	18 59·1	18 55·7	19 22·5	
„ 11	15 10	16 21	P.	5	19 41·5	19 56·7	18 58·4	18 54·9	19 22·9	19 21·3
„ 15	10 58	12 5	C.	5	19 16·6	19 5·4	19 24·4	19 28·3	19 18·7	
„ 18	15 10	16 45	V. N.	5	19 27·0	19 33·4	19 1·9	19 11·5	19 18·4	
„ 22	11 37	12 52	P.	5	19 48·4	19 50·1	18 48·1	19 2·4	19 22·2	
„ 25	15 10	16 24	P.	5	19 46·2	19 37·7	18 57·0	19 3·1	19 21·0	
MAR. 1	11 5	12 26	V.	5	19 23·1	20 32·2	18 24·6	18 58·4	19 19·6	
„ 4	15 9	16 33	V.	5	19 35·4	20 38·7	18 17·6	18 55·5	19 21·8	
„ 8	10 56	12 14	P.	5	19 51·7	19 58·2	18 34·2	19 9·0	19 23·3	
„ 11	15 10	16 23	P.	5	19 38·9	19 38·8	18 46·2	19 4·8	19 17·2	
„ 14	11 9	12 32	V.	5	19 46·9	19 40·4	18 52·6	19 1·2	19 20·3	19 20·7
„ 18	15 9	16 31	V.	5	19 38·7	20 14·8	18 40·5	18 58·0	19 23·0	
„ 22	10 56	12 5	C.	5	19 7·7	19 23·7	19 10·5	19 39·8	19 20·4	
„ 25	15 6	16 21	P.	5	19 42·1	19 47·8	18 50·9	19 4·1	19 21·2	
„ 29	11 6	12 24	V.	5	19 15·1	20 57·6	18 47·7	18 16·9	19 19·3	
APRIL 1	15 9	16 27	V.	5	19 42·7	20 22·6	18 28·0	18 53·7	19 21·7	
„ 5	10 59	12 8	P.	5	19 45·7	20 2·0	18 41·4	18 59·7	19 22·2	
„ 8	15 15	16 29	P.	5	19 55·9	20 10·8	18 17·4	18 53·1	19 19·3	
„ 12	11 10	12 27	V.	5	20 2·9	20 29·2	18 2·6	18 49·9	19 21·1	
„ 15	15 3	16 20	P.	5	19 49·2	20 23·6	18 25·4	18 50·9	19 22·3	19 20·9
„ 19	11 5	12 27	V.	5	20 2·8	19 55·1	18 34·6	18 55·5	19 22·0	
„ 22	15 6	16 28	P.	5	19 46·6	20 8·7	18 28·5	18 55·0	19 19·7	
„ 26	11 9	12 24	V.	5	19 47·7	20 26·6	18 2·8	19 1·0	19 19·5	
„ 29	15 6	16 29	V.	5	19 55·6	20 34·0	18 8·5	18 42·6	19 20·2	
MAY 3	11 0	12 18	P.	5	19 39·2	20 19·6	18 28·3	18 48·1	19 18·8	
„ 6	15 0	16 15	P.	5	19 45·7	20 22·4	18 24·6	18 46·4	19 19·8	
„ 10	11 10	12 25	V.	5	19 34·2	20 18·1	18 28·7	19 9·4	19 22·6	
„ 13	14 36	16 3	V.	5	19 36·5	20 37·2	18 17·8	19 1·8	19 23·3	
„ 17	11 1	12 18	P.	5	19 40·1	20 20·7	18 32·7	18 57·1	19 22·6	19 21·8
„ 20	15 3	16 20	P.	5	19 36·0	20 29·0	18 28·1	18 57·2	19 22·6	
„ 23	11 9	12 33	V.	5	19 47·5	20 23·3	18 18·6	19 9·4	19 24·7	
„ 27	15 9	16 32	V.	5	19 53·0	20 9·6	18 24·9	19 1·1	19 22·1	
„ 31	10 55	12 16	P.	5	19 38·0	20 23·5	18 21·8	18 55·1	19 19·6	
JUNE 3	15 0	16 13	P.	5	19 39·7	20 7·0	18 35·7	19 [illegible]	19 22·0	
„ 7	11 16	12 27	V.	5	19 33·4	20 10·3	18 38·4	19 [illegible]	19 23·0	
„ 10	15 13	16 29	V.	5	19 41·6	20 12·3	18 23·0	19 [illegible]	19 19·8	
„ 14	11 0	12 10	P.	5	19 19·6	20 30·6	18 37·0	18 [illegible]	19 21·5	19 20·2
„ 17	15 3	16 20	P.	5	19 28·7	20 30·1	18 23·6	18 [illegible]	19 20·3	
„ 21	11 6	12 27	V.	5	19 46·1	20 45·9	18 2·2	18 [illegible]	19 19·5	
„ 24	15 13	16 32	V.	5	19 23·1	20 49·8	18 4·9	18 [illegible]	19 17·0	
„ 28	10 56	12 8	P.	5	19 30·5	20 41·6	18 15·7	18 [illegible]	19 18·2	

1881. Date.	Bombay Civil Time (0 to 24 hours). At Commencement.	At Conclusion.	Observer.	Needle marked	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
July 1	15 12	16 22	P.	5	19 36·6	20 27·6	18 24·0	18 44·0	19 18·0	
„ 5	11 13	12 34	V.	5	19 40·2	20 47·8	17 42·4	19 5·6	19 19·0	
„ 8	15 9	16 32	V.	5	19 14·9	20 58·6	17 55·2	19 7·5	19 19·0	
„ 12	11 1	12 22	P.	5	19 28·4	20 21·6	18 24·7	18 46·6	19 15·3	
„ 15	15 10	16 24	P.	5	19 27·3	20 45·5	18 13·4	18 48·1	19 18·6	
„ 19	11 3	12 21	V.	5	19 24·9	20 31·0	18 18·0	19 3·7	19 19·4	
„ 22	15 14	16 34	V.	5	19 27·4	20 28·2	18 11·7	19 11·6	19 19·7	
„ 26	11 6	12 29	V.	5	19 29·8	20 32·6	18 0·2	19 11·3	19 18·5	
„ 29	15 19	16 43	V.	5	19 57·1	20 42·0	17 51·5	18 51·9	19 20·6	
Aug. 2	10 59	12 13	P.	5	19 45·4	20 9·7	18 29·2	18 52·2	19 19·1	
„ 5	15 18	16 31	P.	5	19 22·4	20 32·1	18 11·5	19 7·0	19 18·2	
„ 8	11 5	12 26	V.	5	19 43·5	20 6·9	18 37·6	18 43·7	19 17·9	
„ 12	15 10	16 33	V.	5	19 25·3	20 37·6	18 19·3	18 47·7	19 17·5	
„ 15	11 9	12 29	V.	5	19 20·9	20 56·9	18 29·5	18 28·3	19 18·9	19 18·1
„ 19	15 9	16 33	V.	5	19 13·6	20 21·8	18 24·8	19 5·1	19 16·3	
„ 23	11 3	12 19	P.	5	19 32·6	20 12·4	18 34·4	19 2·4	19 20·4	
„ 26	15 7	16 20	P.	5	19 26·5	20 25·7	18 25·0	18 56·4	19 18·4	
„ 30	11 15	12 33	V.	5	19 55·6	20 41·3	17 40·2	18 48·2	19 16·3	
Sept. 2	15 7	16 28	V.	5	19 43·7	20 44·9	17 56·8	18 46·5	19 18·0	
„ 6	11 4	12 24	V.	5	19 51·7	20 51·4	17 48·9	18 38·6	19 17·6	
„ 9	15 6	16 29	V.	5	19 32·7	21 0·4	18 3·2	18 46·2	19 20·6	
„ 13	11 1	12 15	P.	5	19 26·3	20 36·5	18 25·4	18 36·1	19 16·1	
„ 16	15 14	16 31	P.	5	19 45·7	20 30·4	18 19·5	18 43·0	19 19·6	19 19·8
„ 20	10 58	12 19	P.	5	19 49·9	20 50·1	18 7·5	18 35·4	19 20·7	
„ 23	15 10	16 32	P.	5	19 54·8	20 27·5	18 10·7	18 47·5	19 20·1	
„ 27	11 1	12 19	V.	5	20 8·2	20 27·6	18 15·9	18 23·2	19 18·7	
„ 30	15 10	16 31	V.	5	22 6·2	17 1·9	21 15·7	17 3·6	19 21·8	
Oct. 7	10 56	12 12	P.	5	20 40·9	18 47·6	19 44·6	18 26·5	19 24·9	
The observed Mean Dip of the months January to September 1881 = 19 20·4										
Oct. 4	10 58	12 33	P.	2/81	20 47·0	18 25·4	20 59·9	18 51·0	19 45·8	
„ 7	15 0	16 36	P.	2	20 41·2	18 26·6	20 59·0	18 45·6	19 43·1	
„ 11	11 19	12 46	V.	2	20 3·4	19 30·5	19 42·4	19 25·9	19 40·5	
„ 14	11 10	12 49	V.	5	19 31·9	19 10·5	20 15·5	19 49·9	19 41·9	
„ 14	15 2	16 40	V.	2/81	19 40·0	19 28·1	19 55·5	19 42·1	19 41·4	
„ 18	11 5	12 33	P.	2/81	19 44·4	19 30·2	19 52·5	19 47·9	19 43·7	19 41·6
„ 21	11 2	12 29	P.	5	19 35·0	19 17·6	19 55·9	19 40·1	19 37·1	
„ 21	15 2	16 22	P.	2	20 3·9	19 26·1	19 50·4	19 25·1	19 41·4	
„ 25	11 15	12 49	V.	2	20 42·9	18 32·2	20 6·2	19 17·7	19 39·7	
„ 28	11 10	12 36	V.	5	20 6·6	19 12·0	19 57·1	19 31·1	19 41·7	
„ 28	15 10	16 45	V.	2/81	19 46·8	19 18·9	19 58·2	19 41·6	19 41·4	
Nov. 1	11 45	12 52	P.	2/81	19 50·0	19 28·6	19 56·3	19 45·9	19 45·2	
„ 4	11 0	12 17	P.	5	20 1·4	19 12·4	20 11·1	19 28·4	19 43·3	
„ 4	15 6	16 24	P.	2	20 4·4	19 29·5	19 54·8	19 22·4	19 42·8	
„ 8	11 20	12 46	V.	2	20 0·2	19 20·6	20 29·8	18 56·9	19 41·9	
„ 11	11 5	12 41	V.	5	19 56·6	18 53·6	20 22·8	19 22·3	19 38·8	
„ 11	15 20	16 40	V.	2/81	20 1·9	19 12·1	19 59·9	19 40·0	19 43·5	
„ 15	11 2	12 20	P.	2/81	19 59·5	19 15·0	20 3·9	19 38·2	19 44·1	19 42·4
„ 18	11 0	12 19	P.	5	19 50·6	19 7·7	20 9·9	19 31·4	19 39·9	
„ 18	15 12	16 25	P.	2	20 3·1	19 19·4	20 1·0	19 26·7	19 42·5	
„ 22	11 13	12 47	V.	2	19 42·3	19 5·7	20 25·2	19 21·1	19 38·6	
„ 25	11 13	12 45	V.	5	19 50·1	19 6·1	20 13·3	19 20·4	19 37·5	
„ 25	15 6	16 28	V.	2/81	19 58·8	19 9·7	20 22·7	19 37·1	19 47·1	
„ 29	11 0	12 23	P.	2/81	19 59·6	19 13·6	20 10·0	19 38·6	19 45·4	
Dec. 2	15 34	16 49	P.	2	20 2·4	19 20·2	20 6·7	19 26·5	19 43·9	
„ 6	11 13	12 42	V.	2	20 32·6	18 34·5	20 13·1	19 40·8	19 45·2	
„ 9	15 7	16 34	V.	2/81	19 53·4	19 13·4	20 7·4	19 45·5	19 44·9	
„ 13	11 25	12 50	P.	2/81	19 55·0	19 20·4	20 6·1	19 46·1	19 46·9	
„ 16	15 4	16 21	P.	2	20 11·4	19 15·6	20 4·4	19 31·7	19 45·6	19 45·0
„ 20	11 13	12 42	V.	2	20 23·1	18 42·4	20 11·8	19 34·8	19 43·0	
„ 23	15 19	16 38	V.	2/81	19 53·9	19 7·9	20 10·9	19 43·2	19 44·0	
„ 27	10 45	12 25	V. N.	2/81	19 50·4	19 29·9	19 56·5	19 49·4	19 46·5	
„ 30	15 5	16 23	C.	2	20 14·4	19 11·2	20 16·8	19 16·6	19 44·7	
The observed Mean Dip of the months October to December 1881 = 19 43·0										

Absolute Magnetical Observations.—Table X.

Observations of Vibration and Deflection, taken with the Kew Unifilar Magnetometer (No. 23, by Elliott Brothers), for the determination of Absolute Horizontal Force.

1882.

1882. Date.	Civil Time. Mean.	Magnet N. 23 *a*. Time of one Vibration *b*.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 *c* by N. 23 *a* at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance. 0·8 foot ($X_{0\cdot8}$)	1·0 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8} - X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
JAN. 4	12 18	2·8100	0·87	84·5	+7·1	14·58	81·2	17 56 22	9 6 44	84·4	14·41	82·2	V.	·65239	8·1040	8·1033	+·0007	8·1036		
„ „	15 21	2·8107	0·90	83·0	„	13·80	83·4	17 57 1	9 6 58	84·2	14·04	83·0	V.	·65238	8·0986	8·0986	·0000	8·0986		
„ 11	12 13	2·8100	0·89	87·9	+6·9	14·89	83·0	17 56 2	9 6 32	87·8	14·70	83·3	P.	·65271	8·1049	8·1044	+·0005	8·1046		
„ „	14 59	2·8104	0·91	86·1	„	14·07	83·6	17 56 15	9 6 42	86·8	14·42	83·6	P.	·65274	8·1023	8·1014	+·0009	8·1018		
„ 18	12 9	2·8098	0·80	85·0	+7·7	14·96	79·3	17 55 42	9 6 30	85·7	14·90	79·9	V.	·65245	8·1064	8·1049	+·0015	8·1056		
„ „	15 18	2·8107	0·82	85·9	„	14·25	82·6	17 55 52	9 6 32	86·7	14·52	81·4	V.	·65244	8·1031	8·1020	+·0011	8·1025		
„ 25	12 11	2·8099	0·90	87·0	+7·4	14·80	80·5	17 55 22	9 6 17	86·3	14·73	81·4	P.	·65250	8·1083	8·1074	+·0009	8·1078		
„ „	14 57	2·8105	0·91	85·8	„	13·71	83·9	17 55 37	9 6 25	86·5	14·07	83·1	P.	·65245	8·1046	8·1035	+·0011	8·1040		
FEB. 1	12 20	2·8093	0·73	84·2	+8·8	15·35	79·0	17 55 30	9 6 24	84·1	15·22	79·5	V.	·65232	8·1096	8·1081	+·0015	8·1088		
„ „	15 25	2·8099	0·79	82·5	„	14·50	81·2	17 56 0	9 6 45	84·1	14·78	80·7	V.	·65235	8·1046	8·1023	+·0023	8·1034		
„ 8	12 11	2·8100	0·81	84·9	+7·8	14·56	82·0	17 55 47	9 6 25	86·0	14·50	82·2	P.	·65238	8·1051	8·1046	+·0005	8·1048		
„ „	14 58	2·8104	0·80	87·8	„	13·94	83·4	17 55 57	9 6 32	87·0	14·22	83·0	P.	·65274	8·1049	8·1042	+·0007	8·1045		
„ 15	12 58	2·8099	0·61	86·7	+8·8	15·00	80·9	17 55 41	9 6 26	85·6	14·71	81·1	V.	·65241	8·1083	8·1072	+·0011	8·1077	8·1046	3·7369
„ „	15 53	2·8113	0·45	84·7	„	13·93	82·0	17 56 46	9 7 7	84·4	14·08	81·8	V.	·65242	8·0999	8·0979	+·0020	8·0989		
„ 22	12 11	2·8098	0·54	82·4	+10·6	15·18	78·1	17 56 25	9 6 47	81·6	15·04	78·6	P.	·65215	8·1061	8·1051	+·0010	8·1056		
„ „	14 59	2·8101	0·51	81·1	„	14·47	79·4	17 56 47	9 6 52	81·5	14·60	79 0	P.	·65214	8·1031	8·1029	+·0002	8·1030		
MAR. 1	13 2	2·8087	0·59	81·4	+9·6	15·19	79·9	17 56 32	9 6 42	81·5	15·03	79·9	V.	·65226	8·1079	8·1079	·0000	8·1079		
„ „	15 12	2·8091	0·63	81·0	„	14·64	80·5	17 56 21	9 6 41	81·8	14·78	80·3	V.	·65227	8·1068	8·1064	+·0004	8·1066		
„ 8	12 13	2·8090	0·57	84·5	+9·0	15·13	80·1	17 55 52	9 6 20	84·9	14·96	80·7	P.	·65251	8·1090	8·1094	−·0004	8·1092		
„ „	15 3	2·8097	0·58	85·4	„	14·11	82·0	17 56 25	9 6 35	85·0	14·44	81·5	P.	·65272	8·1057	8·1062	−·0005	8·1059		
„ 15	12 22	2·8100	0·59	86·7	+8·1	14·66	83·5	17 54 50	9 5 52	87·1	14·39	84·0	V.	·65223	8·1094	8·1094	·0000	8·1094		
„ „	15 13	2·8112	0·59	86·7	„	13·73	85·0	17 55 19	9 6 12	87·8	13·84	84·7	V.	·65230	8·1038	8·1031	+·0007	8·1034	8·1069	3·7379
„ 22	12 15	2·8103	0·60	89·7	+7·2	13·95	87·1	17 54 45	9 5 50	89·9	13·63	87·7	P.	·65253	8·1090	8·1090	·0000	8·1090		
„ „	14 59	2·8114	0·62	89·4	„	13·04	88·4	17 55 10	9 6 5	90·0	13·14	88·2	P.	·65254	8·1040	8·1036	+·0004	8·1038		
„ 29	12 8	2·8103	0·54	86·3	+7·0	14·60	85·0	17 54 28	9 5 53	86·5	14·41	85·5	V.	·65208	8·1102	8·1089	+·0013	8·1095		
„ „	14 58	2·8112	0·57	86·3	„	13·73	86·1	17 54 53	9 6 10	87·4	13·84	86·0	V.	·65218	8·1053	8·1033	+·0020	8·1043		

b. Uncorrected for rate of Chronometer.

1882. Date.	Civil Time. Mean.	Magnet N. 23 a. Time of one Vibration b.	Effect of 90° Torsion.	Temperature.	Rate of Chronometer.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Angle of Deflection of Magnet N. 23 c by N. 23 a at Distance. 0·8 foot.	1·0 foot.	Temperature.	Corresponding Mean Reading of L. H. F. Magnetometer. Scale Reading.	Thermometer.	Observer.	Calculated Results in English Units. Values of m.	Values of X. From Deflections at distance. 0·8 foot ($X_{0\cdot8}$)	0·1 foot ($X_{1\cdot0}$)	Difference. $X_{0\cdot8} - X_{1\cdot0}$	Mean. $\frac{X_{0\cdot8}+X_{1\cdot0}}{2}$	Monthly Mean Values of X.	Monthly Mean Values of X in Metrical Units.
1	2	3	4	5	5A	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	h. m.	s.	Sc. divs.	°	s.		°	° ′ ″	° ′ ″	°		°								
April 5	12 21	2·8115	0·56	90·1	+7·3	13·85	84·9	17 55 20	9 6 25	89·0	13·70	85·7	P.	·65257	8·1048	8·1025	+·0023	8·1036		
„ „	15 1	2·8119	0·57	89·2	„	13·13	87·0	17 55 27	9 6 30	89·3	13·44	86·7	P.	·65263	8·1021	8·0997	+·0024	8·1009		
„ 12	12 16	2·8107	0·58	88·4	+8·5	14·82	84·8	17 53 33	9 5 22	88·7	14·52	85·0	V.	·65194	8·1124	8·1115	+·0009	8·1119		
„ „	14 59	2·8131	0·54	88·5	„	13·45	86·0	17 54 50	9 6 2	89·4	13·71	85·7	V.	·65206	8·1003	8·0990	+·0013	8·0996		
„ 19	12 17	2·8124	0·55	88·1	+8·1	13·48	87·0	17 55 51	9 6 22	88·3	12·87	87·4	V. N.	·65199	8·0992	8·0993	−·0001	8·0992	8·1013	3·7353
„ „	15 7	2·8149	0·50	87·2	„	12·07	88·0	17 56 28	9 6 53	88·3	12·34	87·9	V. N.	·65200	8·0891	8·0876	+·0015	8·0883		
„ 26	12 8	2·8130	0·55	89·9	+6·4	13·78	85·9	17 54 31	9 5 47	90·1	13·68	86·4	C.	·65199	8·1021	8·1016	+·0005	8·1018		
„ „	15 4	2·8147	0·52	89·1	„	13·12	87·4	17 54 52	9 6 1	90·0	13·38	87·2	C.	·65178	8·0954	8·0945	+·0009	8·1049		
May 3	12 15	2·8130	0·52	90·3	+6·0	13·36	86·5	17 54 52	9 6 0	90·2	13·30	87·0	P.	·65215	8·1010	8·1003	+·0007	8·1006		
„ „	14 59	2·8139	0·54	90·4	„	12·60	87·4	17 55 12	9 6 7	90·3	12·73	87·3	P.	·65208	8·0971	8·0967	+·0004	8·0969		
„ 10	12 6	2·8125	0·53	91·4	+6·0	14·26	87·0	17 53 15	9 5 13	91·1	14·14	87·3	C.	·65191	8·1085	8·1076	+·0009	8·1080		
„ „	14 58	2·8132	0·52	90·4	„	13·44	88·3	17 53 32	9 5 24	90·6	13·72	88·0	C.	·65188	8·1051	8·1038	+·0013	8·1044		
„ 17	12 8	2·8127	0·53	91·2	+5·6	13·81	86·8	17 53 57	9 5 42	90·8	13·58	87·5	P.	·65203	8·1055	8·1035	+·0020	8·1045	8·1014	3·7354
„ „	14 28	2·8138	0·56	90·5	„	12·98	88·2	17 54 26	9 5 52	90·9	13·21	87·9	P.	·65200	8·0997	8·0982	+·0015	8·0989		
„ 25	12 4	2·8136	0·48	92·5	+5·6	13·64	87·9	17 52 57	9 5 2	93·4	13·63	88·2	V.	·65187	8·1053	8·1046	+·0007	8·1049		
„ „	14 55	2·8151	0·53	92·6	„	12·89	89·0	17 53 45	9 5 31	94·5	13·24	88·9	V.	·65200	8·0971	8·0956	+·0015	8·0963		
„ 31	12 14	2·8144	0·49	92·6	+5·7	13·16	88·9	17 53 3	9 5 8	93·9	12·98	89·0	P.	·65164	8·1021	8·1010	+·0011	8·1015		
„ „	15 1	2·8150	0·53	93·0	„	12·58	90·1	17 53 35	9 5 22	94·2	12·67	89·7	P.	·65179	8·0984	8·0977	+·0007	8·0980		
June 7	12 7	2·8127	0·45	89·9	+3·4	14·06	85·9	17 53 19	9 5 10	89·9	13·78	86·1	V.	·65157	8·1074	8·1072	+·0002	8·1073		
„ „	15 3	2·8141	0·38	89·9	„	13·24	86·8	17 53 42	9 5 26	90·8	13·30	86·5	V.	·65157	8·1012	8·1003	+·0009	8·1007		
„ 14	13 4	2·8119	0·42	85·5	+1·4	14·13	83·9	17 54 51	9 6 0	85·7	13·89	84·0	P.	·65160	8·1040	8·1031	+·0009	8·1035		
„ „	15 21	2·8127	0·42	86·2	„	13·48	84·5	17 55 15	9 6 10	86·4	13·63	84·3	P.	·65181	8·1003	8·0997	+·0006	8·1000	8·1018	3·7356
„ 21	12 12	2·8139	0·40	90·0	+2·8	13·50	85·6	17 54 15	9 5 35	90·7	13·12	86·0	V.	·65157	8·0999	8·0999	·0000	8·0999		
„ „	15 16	2·8144	0·37	89·6	„	12·90	87·0	17 54 18	9 5 36	90·9	13·01	86·5	V.	·65163	8·0977	8·0977	·0000	8·0977		
„ 28	12 14	2·8128	0·38	87·6	+2·7	13·25	84·7	17 54 30	9 5 37	87·2	13·15	84·9	P.	·65158	8·1033	8·1038	−·0005	8·1035		
„ „	15 1	2·8130	0·39	87·1	„	12·87	85·6	17 54 45	9 5 47	87·0	12·97	85·5	P.	·65166	8·1016	8·1020	−·0004	8·1018		
July 5	12 20	2·8113	0·39	83·1	+1·5	14·10	82·0	17 55 22	9 6 8	81·5	13·99	82·1	V.	·65143	8·1057	8·1057	·0000	8·1057		
„ „	15 16	2·8120	0·37	83·8	„	13·69	82·6	17 55 39	9 6 24	83·5	13·91	82·1	V.	·65173	8·1014	8·1005	+·0009	8·1009		
„ 12	12 29	2·8100	0·36	81·8	+1·1	14·78	81·1	17 55 17	9 6 17	81·4	14·47	81·3	V.	·65158	8·1089	8·1074	+·0015	8·1081		
„ „	15 19	2·8121	0·36	81·4	„	13·58	81·5	17 55 31	9 6 20	81·4	13·91	81·5	V.	·65143	8·1016	8·1007	+·0009	8·1011	8·1043	3·7367
„ 19	12 16	2·8122	0·41	81·1	+1·2	14·00	80·9	17 55 12	9 6 0	81·1	14·06	80·9	C.	·65107	8·1023	8·1027	−·0004	8·1025		
„ „	15 1	2·8123	0·42	81·0	„	13·78	81·1	17 55 18	9 6 12	81·0	13·91	81·0	C.	·65115	8·1018	8·1010	+·0008	8·1014		
„ 26	12 12	2·8114	0·41	86·0	+0·8	14·63	82·4	17 53 40	9 5 15	86·0	14·42	83·1	V.	·65145	8·1100	8·1104	−·0004	8·1102		
„ „	15 25	2·8128	0·42	85·7	„	13·61	83·9	17 53 54	9 5 20	86·5	13·95	83·6	V.	·65137	8·1042	8·1048	−·0006	8·1045		

Aug.	2	12 27	2·8122	0·45	84·0	+1·1	13·60	81·9	17 54 15	9 5 37	84·6	13·75	82·1	C.	·65134	8·1049	8·1048	+·0001	8·1048			
„	„	15 19	2·8126	0·42	84·7	„	13·24	83·0	17 54 30	9 5 42	85·0	13·60	82·9	C.	·65146	8·1031	8·1033	−·0002	8·1032			
„	9	12 23	2·8120	0·45	87·0	+0·9	13·81	82·9	17 54 27	9 5 37	86·1	13·61	83·2	C.	·65157	8·1059	8·1064	−·0005	8·1061			
„	„	15 11	2·8135	0·42	86·4	„	13·03	84·0	17 54 47	9 5 55	86·2	13·22	83·9	C.	·65149	8·0999	8·0993	+·0006	8·0996			
„	16	12 33	2·8124	0·50	84·8	+1·1	14·01	83·8	17 54 2	9 5 37	84·9	13·92	83·9	C. & V.G.G.	·65119	8·1053	8·1044	+·0009	8·1048	8·1033	3·7363	
„	„	16 2	2·8126	0·45	82·5	„	13·40	84·0	17 54 35	9 5 50	84·2	13·50	84·0	C. & V.G.G.	·65118	8·1016	8·1010	+·0006	8·1013			
„	23	12 43	2·8138	0·55	86·9	+2·6	13·53	83·9	17 54 0	9 5 37	87·1	13·47	84·3	C. & V.G.G.	·65136	8·1031	8·1020	+·0011	8·1025			
„	„	15 57	2·8141	0·64	86·0	„	13·14	85·2	17 54 9	9 5 42	87·6	13·28	84·9	C. & V.G.G.	·65121	8·0986	8·0975	+·0011	8·0980			
„	30	12 16	2·8134	0·45	88·0	+2·8	13·79	84·6	17 52 40	9 4 51	87·2	13·79	85·2	C.	·65104	8·1085	8·1081	+·0004	8·1083			
„	„	15 14	2·8135	0·48	85·9	„	13·23	85·8	17 53 . 5	9 5 6	87·4	13·55	85·5	C.	·65110	8·1046	8·1038	+·0008	8·1042			
Sept.	6	12 50	2·8139	0·46	86·3	+1·0	13·57	82·7	17 53 16	9 5 16	86·5	13·57	83·1	V.G.G. & C.	·65094	8·1038	8·1025	+·0013	8·1031			
„	„	16 6	2·8144	0·48	84·3	„	12·97	83·4	17 53 34	9 5 23	87·1	13·28	83·4	V.G.G. & C.	·65092	8·0990	8·0980	+·0010	8·0985			
„	14	12 9	2·8123	0·46	87·1	+0·7	14·34	82·0	17 52 57	9 5 5	85·7	14·27	82·4	C.	·65118	8·1111	8·1100	+·0011	8·1105			
„	„	15 7	2·8133	0·44	86·5	„	13·57	83·0	17 53 14	9 5 15	86·1	13·80	83·0	C.	·65113	8·1062	8·1049	+·0013	8·1055	8·1026	3·7359	
„	20	12 18	2·8137	0·50	87·8	+1·7	13·81	84·0	17 53 16	9 5 10	87·3	13·78	84·4	V. G. G.	·65110	8·1049	8·1044	+·0005	8·1046			
„	„	15 48	2·8143	0·46	86·0	„	13·42	85·1	17 53 24	9 5 12	87·8	13·65	84·9	V. G. G.	·65100	8·1008	8·1005	+·0003	8·1006			
„	27	12 39	2·8146	0·48	88·3	+1·4	13·31	84·0	17 53 41	9 5 25	87·9	13·29	84·2	C.	·65109	8·1007	8·0999	+·0008	8·1003			
„	„	15 9	2·8149	0·46	87·4	„	13·08	85·0	17 54 0	9 5 40	87·7	13·21	84·6	C.	·65110	8·0982	8·0967	+·0015	8·0974			
Oct.	4	12 37	2·8149	0·48	86·3	+1·3	13·01	82·8	17 54 57	9 6 0	84·5	12·85	83·1	V. G. G.	·65094	8·0967	8·0962	+·0005	8·0964			
„	„	15 46	2·8154	0·47	86·2	„	12·37	84·1	17 55 36	9 6 17	85·9	12·44	83·8	V. G. G.	·65116	8·0915	8·0913	+·0002	8·0914			
„	11	12 8	2·8147	0·54	89·2	+3·9	13·28	84·9	17 53 14	9 5 8	88·3	13·16	85·4	C.	·65100	8·1027	8·1023	+·0004	8·1025			
„	„	15 7	2·8154	0·55	88·2	„	12·68	86·9	17 53 43	9 5 27	88·5	12·88	86·1	C.	·65100	8·0979	8·0969	+·0010	8·0974	8·1011	3·7353	
„	18	12 23	2·8147	0·53	86·7	+2·8	13·92	84·5	17 50 27	9 3 52	86·6	13·64	85·0	V. G. G.	·64985	8·1122	8·1109	+·0013	8·1115			
„	„	15 40	2·8152	0·54	85·7	„	13·00	86·1	17 51 15	9 4 25	87·5	13·09	85·9	V. G. G.	·65011	8·1059	8·1036	+·0023	8·1047			
„	26	12 16	2·8147	0·58	88·2	+4·6	13·61	84·0	17 52 41	9 4 58	88·4	13·64	84·1	C.	·65085	8·1038	8·1025	+·0013	8·1031			
„	„	15 3	2·8149	0·60	89·5	„	13·22	84·8	17 52 48	9 5 0	90·5	13·46	84·1	C.	·65112	8·1020	8·1010	+·0010	8·1015			
Nov.	1	12 16	2·8140	0·57	86·3	+6·4	14·57	81·6	17 53 20	9 5 13	84·8	14·29	82·4	V. G. G.	·65070	8·1053	8·1046	+·0007	8·1049			
„	„	15 33	2·8155	0·58	84·6	„	13·56	84·1	17 54 1	9 5 31	87·3	13·78	83·5	V. G. G.	·65074	8·0945	8·0941	+·0004	8·0943			
„	8	12 11	2·8132	0·64	87·2	+4·5	14·42	81·0	17 52 52	9 5 6	86·4	14·15	81·6	C.	·65092	8·1081	8·1066	+·0015	8·1073			
„	„	15 3	2·8150	0·61	85·9	„	13·43	83·8	17 53 9	9 5 17	87·9	13·67	83·2	C.	·65080	8·0995	8·0977	+·0018	8·0986			
„	15	12 21	2·8131	0·60	86·2	+7·1	14·55	81·2	17 53 15	9 5 19	84·2	14·32	81·8	V. G. G.	·65086	8·1085	8·1068	+·0017	8·1076	8·0985	3·7341	
„	„	15 32	2·8150	0·58	84·8	„	13·60	83·0	17 52 40	9 5 5	85·4	14·00	82·0	V. G. G.	·65047	8·1029	8·1008	+·0021	8·1018			
„	22	12 11	2·8165	0·64	86·2	+6·5	12·82	80·9	17 55 37	9 6 29	86·6	12·71	81·0	C.	·65098	8·0880	8·0863	+·0017	8·0871			
„	„	15 3	2·8170	0·61	86·0	„	12·40	82·7	17 56 2	9 6 39	87·4	12·60	81·5	C.	·65109	8·0841	8·0828	+·0013	8·0834			
„	29	13 22	2·8147	0·61	88·1	+4·3	13·89	83·1	17 53 1	9 5 12	86·4	13·50	84·3	V. G. G.	·65068	8·1042	8·1025	+·0017	8·1033			
„	„	16 32	2·8156	0·61	85·7	„	13·11	84·4	17 53 37	9 5 32	86·1	13·28	84·5	V. G. G.	·65067	8·0977	8·0956	+·0021	8·0966			
Dec.	6	12 6	2·8137	0·66	85·1	+6·6	14·41	80·1	17 53 25	9 5 20	85·3	14·24	80·4	C.	·65077	8·1042	8·1029	+·0013	8·1035			
„	„	15 3	2·8144	0·60	84·7	„	13·86	82·1	17 54 3	9 5 36	86·7	14·01	81·2	C.	·65092	8·0982	8·0973	+·0009	8·0977			
„	13	12 15	2·8138	0·65	83·1	+6·9	14·41	80·1	17 53 57	9 5 33	82·4	14·22	80·5	V. G. G.	·65055	8·1031	8·1021	+·0010	8·1026			
„	„	15 17	2·8148	0·59	82·2	„	13·62	81·4	17 55 1	9 6 5	82·5	13·83	81·0	V. G. G.	·65071	8·0954	8·0945	+·0009	8·0949	8·0995	3·7345	
„	20	12 10	2·8137	0·60	87·0	+6·5	14·20	81·0	17 53 32	9 5 17	86·5	14·07	81·0	C.	·65101	8·1044	8·1038	+·0006	8·1041			
„	„	14 57	2·8146	0·66	86·0	„	13·63	82·4	17 53 46	9 5 22	88·6	13·89	81·4	C.	·65104	8·0980	8·0979	+·0001	8·0979			
„	27	12 29	2·8141	0·66	85·1	+8·5	14·25	79·7	17 53 50	9 5 27	86·0	14·16	79·9	V. N.	·65088	8·1010	8·1005	+·0005	8·1007			
„	„	15 45	2·8157	0·79	86·0	„	13·71	82·9	17 53 53	9 5 40	87·0	13·95	81·2	V. N.	·65071	8·0958	8·0938	+·0020	8·0948			
																			The mean value of the Horizontal Force for the year 1882 =		8·1024	3·7359

b. Uncorrected for rate of Chronometer.

Absolute Magnetical Observations.—Table XI.

Observations of Absolute Declination.

1882.

1882. Date.	Bombay Civil Time.	Mean Readings. Collimator Magnet. Scale apparently Erect.	Collimator Magnet. Scale apparently Inverted.	Horizontal Circle with Telescope pointed to. Scale of Collimator Magnet.	Horizontal Circle with Telescope pointed to. Târdeo Chimney.	Torsion. Mean.	Torsion. Effect of 90°.	Observer.	Corresponding Reading of large Declination Magnetometer.	Absolute Easterly Declination corrected for Torsion.	Monthly Mean. Corresponding Reading of large Declination Magnetometer.	Monthly Mean. Absolute Easterly Declination.
1	2	3	4	5	6	7	8	9	10	11	12	13
	h. m.	Sc. div.	Sc. div.	° ′ ″	° ′ ″	°	Sc. div.		Sc. div.	° ′ ″	Sc. div.	° ′ ″
JAN. 5	11 26	+1·56	+1·55	17 20 12	196 49 55	0		V.	36·88	0 56 43		
„ 13	11 28	+1·57	+1·57	17 19 52	196 50 30	0		P.	36·73	0 55 48	36·85	0 56 29
„ 19	11 18	+1·52	+1·70	17 20 17	196 49 52	0		V.	36·89	0 56 39		
„ 26	11 17	+1·54	+1·62	17 20 50	196 50 25	0		P.	36·91	0 56 45		
FEB. 2	11 16	+1·57	+1·61	17 20 22	196 49 52	0		V.	36·94	0 56 53		
„ 9	11 24	+1·55	+1·64	17 20 00	196 50 20	0		P.	36·78	0 56 00	36·92	0 56 50
„ 17	11 33	+1·55	+1·55	17 20 12	196 49 55	0		V.	36·88	0 56 43		
„ 23	11 23	+1·52	+1·62	17 21 30	196 50 5	0		P.	37·07	0 57 44		
MAR. 2	11 26	+1·55	+1·79	17 19 40	196 49 35	0		V.	36·83	0 56 14		
„ 9	11 22	+1·54	+1·60	17 19 20	196 49 45	0		P.	36·78	0 55 57		
„ 16	11 33	+1·52	+1·67	17 19 32	196 49 47	0		V.	36·76	0 56 1	36·73	0 55 42
„ 23	11 17	+1·52	+1·70	17 19 00	196 51 00	0		P.	36·50	0 54 14		
„ 30	11 27	+1·52	+1·71	17 20 27	196 50 35	0		V.	36·79	0 56 6		
APRIL 6	11 18	+1·52	+1·66	17 21 20	196 50 7	0		V. N.	36·99	0 57 29		
„ 13	11 31	+1·55	+1·62	17 18 57	196 50 25	0		V.	36·58	0 54 54	36·77	0 56 6
„ 20	11 24	+1·51	+1·72	17 21 00	196 50 15	0		P.	36·92	0 56 57		
„ 27	11 28	+1·62	+1·60	17 19 2	196 50 25	0		C.	36·61	0 55 4		
MAY 4	11 21	+1·60	+1·65	17 19 35	196 50 32	0		P.	36·65	0 55 26		
„ 11	11 8	+1·56	+1·65	17 17 37	196 50 30	0		C.	36·36	0 53 27	36·53	0 54 41
„ 18	11 8	+1·50	+1·75	17 19 25	196 50 32	0		P.	36·56	0 55 2		
„ 26	11 21	+1·51	+1·65	17 19 20	196 50 47	0		V.	36·54	0 54 49		
JUNE 1	11 19	+1·50	+1·65	17 20 10	196 50 30	0		P.	36·70	0 55 56		
„ 8	11 21	+1·52	+1·62	17 19 2	196 50 27	0		V.	36·53	0 54 54		
„ 15	11 29	+1·52	+1·62	17 16 40	196 50 20	0		P.	36·23	0 52 39	36·57	0 55 6
„ 22	11 17	+1·51	+1·71	17 19 25	196 50 30	0		V.	36·57	0 55 7		
„ 29	11 21	+1·54	+1·64	17 20 40	196 50 7	0		P.	36·80	0 56 52		
JULY 6	11 25	+1·52	+1·69	17 19 17	196 49 35	0		V.	36·68	0 55 57		
„ 13	11 18	+1·55	+1·52	17 16 20	196 48 55	0		V.	36·34	0 53 52	36·55	0 55 11
„ 20	11 8	+1·54	+1·57	17 18 2	196 48 27	0		C.	36·68	0 56 0		
„ 27	11 33	+1·52	+1·71	17 16 37	196 47 57	0		V.	36·49	0 54 54		
AUG. 3	11 42	+1·52	+1·61	17 18 20	196 49 22	0		C.	36·58	0 55 18		
„ 10	11 35	+1·54	+1·61	17 15 37	196 48 12	0		C.	36·37	0 53 47		
„ 17	11 43	+1·51	+1·76	17 16 0	196 48 15	15 E.	0·32	V. G. G.	36·36	0 53 47	36·48	0 54 38
„ 24	11 42	+1·52	+1·67	17 17 10	196 47 57	0		V. G. G.	36·59	0 55 29		
„ 31	11 34	+1·52	+1·64	17 16 10	196 47 37	0		C.	36·49	0 54 51		
SEPT. 7	11 39	+1·54	+1·67	17 16 32	196 47 10	0		V. G. G.	36·64	0 55 40		
„ 15	11 33	+1·52	+1·65	17 15 27	196 46 27	0		C.	36·58	0 55 18	36·60	0 55 27
„ 21	11 29	+1·55	+1·52	17 15 40	196 46 40	0		V. G. G.	36·61	0 55 27		
„ 28	11 29	+1·55	+1·57	17 15 12	196 46 22	10 W.	0·68	C.	36·59	0 55 25		
OCT. 5	11 28	+1·54	+1·67	17 16 25	196 45 57	0		V. G. G.	36·82	0 56 46		
„ 12	11 28	+1·55	+1·61	17 14 17	196 45 35	0		C.	36·59	0 55 4	36·77	0 56 15
„ 19	11 24	+1·55	+1·62	17 15 27	196 44 57	0		V. G. G.	36·89	0 56 52		
„ 27	11 28	+1·55	+1·59	17 15 12	196 45 15	0		C.	36·80	0 56 20		
NOV. 2	11 25	+1·55	+1·62	17 15 20	196 45 2	0		V. G. G.	36·84	0 56 40		
„ 10	11 27	+1·55	+1·60	17 15 37	196 45 5	0		C.	36·89	0 56 55		
„ 16	11 23	+1·57	+1·56	17 14 32	196 45 35	0		V. G. G.	36·68	0 55 23	36·90	0 56 52
„ 23	11 27	+1·55	+1·57	17 17 25	196 45 50	0		C.	37·10	0 58 00		
„ 30	11 28	+1·55	+1·56	17 17 20	196 46 25	0		V. G. G.	36·99	0 57 21		
DEC. 7	11 27	+1·55	+1·57	17 17 22	196 46 57	0		C.	36·90	0 56 50		
„ 14	11 25	+1·55	+1·60	17 17 42	196 46 30	0		V. G. G.	37·01	0 57 35		
„ 21	11 27	+1·56	+1·51	17 19 7	196 46 52	0		C.	37·19	0 58 44	37·02	0 57 39
„ 28	11 43	+1·55	+1·60	17 18 5	196 47 0	0		P.	37·00	0 57 28		

The Mean Declination for the year 1882 = 0 ° 55 ′ 55 ″

Absolute Magnetical Observations.—Table XII.

OBSERVATIONS OF INCLINATION, 1882.

Taken with Barrow's Dip Circle, with Microscopes, No. 49 and two 3½-inch Needles Nos. 2 and $\frac{2}{81}$, by John Dover.

1882. Date.	Bombay Civil Time (0 to 24 hours). At Commencement.	At Conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
JAN. 3	11 20	12 46	V.	2	20 40·5	18 43·9	20 18·6	19 5·2	19 42·0	
„ 6	15 16	16 45	V.	$\frac{2}{81}$	20 4·7	18 57·4	20 10·6	19 43·5	19 44·0	
„ 10	11 0	12 17	P.	$\frac{2}{81}$	19 51·2	19 15·6	20 2·4	19 46·9	19 44·0	
„ 13	15 6	16 25	P.	2	20 16·9	19 8·5	20 6·2	19 23·7	19 43·8	
„ 17	11 4	12 32	V.	2	20 47·2	18 44·5	20 15·7	18 58·1	19 41·4	19 43·5
„ 20	15 15	16 34	V.	$\frac{2}{81}$	19 54·2	19 15·4	19 58·7	19 49·6	19 44·5	
„ 24	11 1	12 20	P.	$\frac{2}{81}$	19 56·7	19 23·6	20 8·1	19 43·0	19 47·8	
„ 27	15 1	16 16	P.	2	20 12·9	19 6·2	20 16·4	19 12·7	19 42·0	
„ 31	11 19	12 42	V.	2	20 52·5	18 17·6	20 40·5	18 56·9	19 41·9	
FEB. 3	15 15	16 40	V.	$\frac{2}{81}$	19 58·5	19 7·8	20 17·9	19 37·9	19 45·5	
„ 7	11 0	12 24	P.	$\frac{2}{81}$	20 2·1	19 13·1	20 9·1	19 41·7	19 46·5	
„ 10	15 14	16 26	P.	2	20 18·6	19 2·6	20 25·1	18 57·2	19 40·9	
„ 14	11 18	12 38	V.	2	20 51·2	18 31·4	20 30·5	19 0·5	19 43·4	
„ 17	15 13	16 32	V.	$\frac{2}{81}$	19 54·6	19 23·1	20 3·7	19 32·8	19 43·5	19 43·5
„ 21	11 0	12 14	P.	$\frac{2}{81}$	19 54·6	19 23·5	20 5·2	19 35·4	19 44·7	
„ 24	15 4	16 25	P.	2	20 14·2	19 17·2	20 12·4	19 3·9	19 41·9	
„ 28	11 20	12 43	V.	2	20 34·2	18 52·2	20 35·7	18 45·9	19 42·0	
MARCH 3	15 21	16 35	V.	$\frac{2}{81}$	19 51·1	19 19·0	20 18·9	19 33·1	19 45·5	
„ 7	10 55	12 25	P.	$\frac{2}{81}$	19 51·1	19 25·1	20 9·2	19 34·0	19 44·8	
„ 10	15 6	16 22	P.	2	20 17·6	19 11·5	20 21·6	18 56·7	19 41·8	
„ 14	11 19	12 46	V.	2	20 28·4	18 56·9	20 16·2	19 4·1	19 41·4	
„ 17	15 28	16 34	V.	$\frac{2}{81}$	19 52·9	19 13·9	20 13·9	19 37·6	19 44·6	19 43·6
„ 21	11 0	12 9	P.	$\frac{2}{81}$	19 52·1	19 18·2	20 11·6	19 37·7	19 44·9	
„ 24	15 2	16 22	P.	2	20 18·9	19 11·5	20 15·4	19 4·8	19 42·6	
„ 28	11 2	12 22	P.	2	20 23·1	19 10·2	20 16·2	18 55·5	19 41·2	
„ 31	15 11	16 25	V.	$\frac{2}{81}$	19 52·4	19 14·9	20 2·1	19 52·2	19 45·4	
APRIL 4	11 7	12 17	P.	$\frac{2}{81}$	19 49·4	19 17·6	20 10·4	19 46·7	19 46·0	
„ 7	15 50	16 55	V. N.	2	20 23·4	19 15·4	19 49·2	19 16·9	19 41·2	
„ 11	11 18	12 36	V.	2	20 31·2	19 3·6	20 5·7	19 4·6	19 41·0	
„ 14	15 26	16 29	V.	$\frac{2}{81}$	19 57·2	19 21·3	19 48·2	19 51·8	19 44·6	
„ 18	11 11	12 37	P.	$\frac{2}{81}$	19 51·7	19 26·2	20 2·1	19 49·9	19 47·5	19 43·2
„ 21	15 34	16 40	P.	2	20 21·6	19 16·9	20 1·6	19 9·7	19 42·4	
„ 25	10 58	12 19	C.	2	19 59·9	19 17·4	20 1·6	19 12·7	19 37·9	
„ 28	15 17	16 29	C.	$\frac{2}{81}$	19 47·1	19 26·7	20 7·0	19 38·6	19 44·8	

1882. Date.	Bombay Civil Time (0 to 24 hours). At Commencement.	At Conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
MAY 2	10 58	12 9	P.	$\frac{2}{81}$	19 48·6	19 19·6	20 7·2	19 41·7	19 44·3	
„ 5	15 5	16 26	P.	2	20 18·6	19 17·8	20 2·5	19 8·7	19 41·9	
„ 9	10 59	12 12	C.	2	20 3·1	19 20·9	20 2·5	19 8·4	19 38·7	
„ 12	15 10	16 21	C.	$\frac{2}{81}$	19 50·7	19 20·7	20 0·0	19 44·5	19 44·0	
„ 16	10 59	12 21	P.	$\frac{2}{81}$	19 46·2	19 27·5	20 4·5	19 44·9	19 45·8	19 43·2
„ 19	15 6	16 25	P.	2	20 0·1	19 31·6	20 8·0	19 4·6	19 41·1	
„ 23	11 13	12 29	V.	2	19 48·8	19 20·6	20 19·2	19 15·6	19 41·0	
„ 26	15 15	16 39	V.	$\frac{2}{81}$	19 50·2	19 31·3	19 55·9	19 43·3	19 45·2	
„ 30	11 5	12 26	P.	$\frac{2}{81}$	19 46·7	19 33·3	20 4·7	19 43·5	19 47·0	
JUNE 2	15 4	16 28	P.	2	20 9·5	19 27·2	20 0·2	19 7·6	19 41·1	
„ 6	11 13	12 37	V.	2	20 5·6	19 18·5	20 3·0	19 15·2	19 40·6	
„ 9	15 15	16 36	V.	$\frac{2}{81}$	19 58·1	19 10·4	20 16·5	19 43·3	19 47·1	
„ 13	11 13	12 31	P.	$\frac{2}{81}$	19 58·4	19 23·4	20 10·7	19 41·0	19 48·4	
„ 16	15 13	16 42	V.	2	20 21·9	18 53·1	20 12·2	19 13·3	19 40·1	19 43·3
„ 20	11 15	12 43	V.	2	19 50·7	19 11·4	20 17·3	19 19·7	19 39·8	
„ 23	15 16	16 45	V.	$\frac{2}{81}$	19 51·3	19 21·1	20 21·9	19 39·6	19 48·5	
„ 27	11 7	12 18	P.	$\frac{2}{81}$	19 51·5	19 13·3	20 17·3	19 32·2	19 43·6	
„ 30	15 11	16 24	P.	2	20 16·7	19 6·2	20 18·0	19 0·5	19 40·3	
JULY 4	11 15	12 37	V.	2	19 57·6	19 1·4	20 38·2	18 55·8	19 38·2	
„ 7	15 13	16 37	V.	$\frac{2}{81}$	20 4·1	19 1·1	20 24·2	19 25·3	19 43·7	
„ 11	11 10	12 37	V.	$\frac{2}{81}$	20 11·2	18 57·7	20 24·2	19 30·4	19 45·9	
„ 14	15 15	16 26	V.	2	20 48·4	18 36·3	20 38·1	18 45·2	19 42·0	19 41·8
„ 18	11 5	12 18	C.	2	20 13·6	18 57·4	20 22·5	19 11·7	19 41·3	
„ 21	15 6	16 16	C.	$\frac{2}{81}$	20 2·7	19 2·6	20 16·6	19 27·9	19 42·4	
„ 25	11 15	12 47	V.	$\frac{2}{81}$	20 7·1	18 52·2	20 20·4	19 28·2	19 42·0	
„ 28	15 4	16 22	C.	2	20 19·3	18 53·9	20 30·9	18 51·4	19 38·9	
AUG. 1	11 24	12 37	C.	2	20 25·4	18 54·4	20 27·6	19 7·1	19 43·6	
„ 4	15 6	16 17	C.	$\frac{2}{81}$	20 3·1	19 1·6	20 15·4	19 31·8	19 43·0	
„ 8	11 8	12 22	C.	$\frac{2}{81}$	20 2·3	19 0·8	20 20·6	19 32·5	19 44·0	
„ 11	15 6	16 24	C.	2	20 22·7	18 52·7	20 19·4	19 12·1	19 41·7	
„ 15	11 15	13 27	V.G.G.	2	20 2·7	19 10·9	20 16·6	19 4·5	19 38·7	19 42·1
„ 18	14 55	16 43	V.G.G.	$\frac{2}{81}$	19 58·7	19 12·0	20 11·6	19 33·9	19 44·0	
„ 22	11 16	12 55	V.G.G.	$\frac{2}{81}$	19 54·2	19 15·2	20 11·4	19 36·6	19 44·3	
„ 25	14 55	16 35	V.G.G.	2	20 7·0	19 9·2	20 12·4	19 5·2	19 38·4	
„ 29	11 17	12 30	C.	2	20 15·7	19 1·8	20 18·6	19 7·1	19 40·8	
SEPT. 1	15 9	16 24	C.	$\frac{2}{81}$	20 1·2	19 7·4	20 19·1	19 29·7	19 44·3	
„ 5	11 18	12 56	V.G.G.	$\frac{2}{81}$	19 55·4	19 15·4	20 13·1	19 31·6	19 43·9	
„ 8	15 5	16 45	V.G.G.	2	20 2·5	19 12·2	20 16·7	19 4·9	19 39·1	
„ 12	11 21	12 33	C.	2	20 13·8	19 2·8	20 15·7	19 3·5	19 38·9	
„ 15	15 13	16 24	C.	$\frac{2}{81}$	19 58·9	19 9·7	20 14·7	19 39·2	19 45·6	19 42·3
„ 19	11 17	12 50	V.G.G.	$\frac{2}{81}$	19 57·5	19 11·2	20 13·4	19 38·6	19 45·2	
„ 22	15 10	16 45	V.G.G.	2	20 3·0	19 11·4	20 17·4	19 5·1	19 39·2	
„ 26	11 16	12 34	C.	2	20 5·7	19 2·9	20 20·1	19 9·5	19 39·5	
„ 29	15 14	16 27	C.	$\frac{2}{81}$	20 0·9	19 10·4	20 16·0	19 32·9	19 45·0	

1882. Date.	Bombay Civil Time (0 to 24 hours). At Commencement.	At Conclusion.	Observer.	Needle marked.	End of Needle Dipping. A. Face of Circle. East.	A. Face of Circle. West.	B. Face of Circle. East.	B. Face of Circle. West.	Mean Dip.	Monthly Mean.
	h. m.	h. m.			° ′	° ′	° ′	° ′	° ′	° ′
Oct. 3	11 14	12 48	V.G.G.	$\frac{2}{81}$	20 2·1	19 9·2	20 16·2	19 33·6	19 45·3	
„ 6	15 8	16 31	V.G.G.	2	20 13·5	19 2·4	20 18·0	19 3·5	19 39·3	
„ 10	11 18	12 31	C.	2	20 8·5	19 5·6	20 12·7	19 15·1	19 40·5	
„ 13	15 12	16 30	C.	$\frac{2}{81}$	20 3·7	19 14·2	20 16·4	19 32·7	19 46·8	
„ 17	11 12	12 40	V.G.G.	$\frac{2}{81}$	20 1·5	19 11·5	20 15·5	19 38·6	19 46·8	19 43·4
„ 20	15 5	16 41	V.G.G.	2	20 22·0	19 1·0	20 11·7	19 4·9	19 39·9	
„ 24	11 28	12 40	C.	2	20 18·8	18 58·6	20 10·6	19 7·5	19 38·9	
„ 27	15 10	16 29	C.	$\frac{2}{81}$	19 58·9	19 9·8	20 19·7	19 39·4	19 46·9	
„ 31	11 18	12 48	V.G.G.	$\frac{2}{81}$	19 59·6	19 8·9	20 18·2	19 39·9	19 46·6	
Nov. 3	15 12	16 36	V.G.G.	2	20 20·0	18 59·4	20 12·2	19 4·5	19 39·0	
„ 7	11 17	12 31	C.	2	20 10·2	19 11·4	20 6·2	19 4·8	19 38·1	
„ 10	15 14	16 29	C.	$\frac{2}{81}$	19 57·3	19 11·2	20 17·7	19 36·9	19 45·8	
„ 14	11 7	12 40	V.G.G.	$\frac{2}{81}$	19 57·7	19 11·0	20 18·2	19 35·7	19 45·6	
„ 17	15 5	16 35	V.G.G.	2	20 21·2	19 5·4	20 6·9	19 3·1	19 39·1	19 41·6
„ 21	11 10	12 25	C.	2	20 18·2	19 3·1	19 53·6	19 4·2	19 34·8	
„ 24	15 7	16 25	C.	$\frac{2}{81}$	19 57·0	19 13·7	20 16·9	19 31·6	19 44·8	
„ 28	11 10	12 30	V.G.G.	$\frac{2}{81}$	19 54·6	19 13·4	20 17·5	19 36·0	19 45·4	
Dec. 1	15 15	16 32	V.G.G.	2	20 28·9	19 1·2	19 54·2	19 5·6	19 37·5	
„ 5	11 12	12 29	C.	2	20 16·9	19 7·2	20 3·3	19 8·5	19 39·0	
„ 8	15 8	16 25	C.	$\frac{2}{81}$	19 54·0	19 12·9	20 17·2	19 38·3	19 45·6	
„ 12	11 15	12 40	V.G.G.	$\frac{2}{81}$	20 2·1	19 8·1	20 6·5	19 44·6	19 45·3	
„ 15	15 6	16 28	V.G.G.	2	20 17·0	19 6·0	20 2·5	19 7·9	19 38·3	19 42·2
„ 19	11 14	12 29	C.	2	20 14·4	19 7·1	20 4·9	19 10·2	19 39·1	
„ 22	15 9	16 23	C.	$\frac{2}{81}$	19 59·5	19 7·9	20 12·6	19 43·1	19 45·8	
„ 26	11 12	12 41	P.	$\frac{2}{81}$	20 0·2	19 11·1	20 10·9	19 42·2	19 46·1	
„ 29	15 20	17 0	V.N.	2	19 54·0	19 34·8	20 2·9	19 21·5	19 43·3	

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The Mean Dip for the year 1882 = 19 42·8

APPENDICES

TO THE

BOMBAY MAGNETICAL AND METEOROLOGICAL OBSERVATIONS,

1879 TO 1882.

B 325

BOMBAY

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS,

1879—1882.

Appendices I to V.

I.—History of the set of Magnetographs established at the Colába Observatory, with a new theory of the Vertical force Magnetometer.

II.—On the Solar and Lunar Variation of Magnetic Declination at Bombay in the Years 1846 to 1872.

III.—On the Solar and Lunar Variation of the Horizontal Component of the Earth's Magnetic force at Bombay in the Years 1847 to 1872.

IV.—The Solar Diurnal Variations of Declination, Horizontal Force, and Vertical Force at Bombay, as derived from the registrations of the Colába Magnetographs.

V.—Influence of height above or below the ground level upon the Diurnal Variations of Declination and Horizontal Force.

By

CHARLES CHAMBERS, F. R. S.

Superintendent of the Colába Observatory.

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PREFACE TO APPENDICES.

The attention of magneticians is particularly called to the treatment, in these Appendices, of the following questions, viz.—

(1.) Of the necessity of taking account of the curvature of the knife-edge of the vertical force magnetometer (Paragraphs 18 to 72).

(2.) That the scale-coefficient of the vertical force magnetograph is a function of the temperature of the instrument and also of the time (Paragraphs 54 and 55).

(3.) On the temperature-compensation of the vertical force magnetograph (Paragraphs 73 to 82).

(4.) On the conditions which should determine the degree of sensitiveness chosen for the vertical force magnetograph (Paragraph 86).

(5.) Evidences of the sun-spot period in various magnetic phenomena (Paragraphs 140, 150, 226 and 234).

(6.) Method of calculating the totality of disturbance from observations of disturbance exceeding a fixed limit (Paragraph 142).

(7.) Coefficients of harmonic series expressing the solar and lunar diurnal variations of declination and horizontal force (Paragraphs 148, 164, 232 and 243; and Tables 53, 60 to 63, 104 and 105, and 113 to 116).

(8.) That the absolute easterly declination and absolute horizontal force both reached maximum values in the year 1879 (Paragraphs 159 and 241).

(9.) The lunar diurnal variations of declination and horizontal force for different quarters of the year and phases of the moon lead to the hypothesis that the period is the solar day, and that the variation is of the same character at new moon and full moon and the same at first quarter and last quarter, but of reverse character at new moon and first quarter (Paragraphs 167 and 248).

(10.) Trial of the solar day as the period corrects the hypothesis, showing that the period is the lunar day but that the phases slip backward six lunar hours every seven or eight days—the character of the variation being at the same time inverted (Paragraphs 169*a* and 169*b*).

(11.) The mode of reversal of the character of the lunar variation curves and of the slipping of the phases is by the waning and disappearance of the afternoon inflexions and by the birth and growth of morning inflexions (Paragraph 169*c*). Corresponding changes traced in a particular case (Paragraph 169*d*).

(12.) The probable similarity of character of the luni-solar variations of declination and horizontal force, but with a difference of phase of three hours. Some evidence adduced. (Paragraph 249*a*).

(13.) Modification of the ordinary theory of the horizontal force magnetometer so as to take account of the torsion of the suspension wires about themselves (Paragraph 206).

(14.) Evidence that the torsion of the wires varies with time (Paragraphs 207 and 208). A case of secular untwisting of a silver wire.

(15.) An artifice for eliminating the effect of the torsion of the wires (Paragraph 209).

(16.) The determination of the scale-coefficient by means of deflection experiments is more accurate than the use of the usual formula (Paragraph 212).

(17.) Evidence that the horizontal force, at height of six feet above the ground is not, in its variations from *day to day*, but may be in its variations from hour to hour, a function of the natural temperature of the place of observation (Paragraph 222).

Colába Observatory, Bombay, April 1883.

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Page [31] Table 10, column 2, last line,	*for* $\frac{14\cdot26}{51\cdot785}$	*read* $\frac{16\cdot3}{51\cdot785}$
„ [37] line 2 from top	„ values	„ value.
„ [37] „ 3 „ „	„ s	„ S
„ [39] „ 3 from bottom	„ Y	„ Y_1
„ [43] „ 5 „ „ of second foot note	„ fall	„ rise
„ [46] last line	„ give	„ gives
„ [47] Table 21 column 6 heading	„ sT	„ cT
„ [55] line 7 from bottom	„ $\frac{26}{1760\cdot1}$	„ $\frac{26}{1760\cdot1}$
„ [74] „ 21 „ „	„ *cot* 50′	„ *tan* 50′
„ [83] at end. *Insert* N . . . . . Naro Bálcrishna		
„ „ „ „ K . . . . . Keshav Pandurang		
„ [96] in equation (α)	*for* $\frac{A}{c\sqrt{\pi}}$	*read* $\frac{A}{c\sqrt{\pi}}$
„ „ (γ)	„ $\frac{O}{2\sqrt{\pi}}$	„ $\frac{c}{2\sqrt{\pi}}$
„ [97] Table 47 heading of columns 17 & 18	„ $\frac{}{2\sqrt{\pi}}$	„ $\frac{c}{2\sqrt{\pi}}$
„ [112] line 19 from top	„ $2 \sin t z$	„ $2 \sin 2 t z$
„ [137] „ 20 „ „	„ —·000002	„ —·00002
„ [152] „ 14 „ „	„ 1868·5	„ 1869·5
„ [159] Table 89 last line	„ —·011	„ +·011
„ [235] In the list of dislocations . . .	„ 1875 January	„ 1876 January.

PLATES I and II.—The irregularities of the original curves are exaggerated in the lithographic copies, and the latter are otherwise marked by a less regular flow than the numbers which they represent.

APPENDIX I.

History of the set of Magnetographs established at the Colaba Observatory, with a new theory of the vertical force Magnetometer.

This Observatory, like fourteen or fifteen others that have been established or reorganised in various parts of the world since the year 1860, is indebted to the parent institution—the Kew Observatory—both for a successful example of the working of a set of differential magnetographs, for precise directions how to copy that example in the use of instruments of similar construction, for making its experience available for the procuring of a set of instruments of the best character obtainable, and for a careful testing of these instruments, by actual trial, before they were despatched from England.

2. The directions spoken of are contained in "an account—by Dr. Balfour Stewart—of the construction of the self-recording magnetographs at present in operation at the Kew Observatory of the British Association," published in the Report of the Association for 1859 (pages 200 to 228). This account, as modified and enlarged on page 228, applies to the set of magnetographs supplied to and erected at the Colába Observatory in 1869; and the reader's acquaintance with it will be presumed in the remarks that are now made on the special characteristics of the Colába instruments.

3. These are placed in a locality which is effectually removed from neighbouring magnetic influences—the nearest of which is that of vehicles moving along the Colába Road—and in a room the floor of which is 12 feet below the level of the ground and the roof of which is covered with soil to a depth of 3 feet. The magnetograph room, as it is called, has substantial double walls of masonry, with a passage (or air space) between, and a teakwood roof covered with asphalte. Access to it is obtained by a staircase and lobby, the roof of which is also covered with soil. The object of these arrangements is to preserve an equable temperature in the air of the room, in order that the magnetic records should be as purely magnetic as possible, that is, as free from the influence of temperature as it is practicable to make them. This is effectually secured, for the average daily range of temperature in the room is only 0°·4 Faht.; and in three months only, out of the 83 months from February 1872 to December 1878, did that average reach 0°·7 Faht. In the same period the greatest of the mean monthly maxima is 92°·7 and the least of the mean monthly minima 82°·0.

4. Drainage water flows underneath the passage to a well in one corner, and thence —since the monsoon of 1871—to the sea. Before 1871 no natural drain had been provided, and the water had to be pumped or carried out of the room as it accumulated.

5. Controllable ventilation is provided in the following manner: for the admission of fresh air there is a copper tube, with a cowl at top (the mouth of which can be turned to face the wind) and with its lower end—which can be closed at will—near the floor of the room; and there is a wide copper pipe, which also can be closed at will, leading from the room to the lobby and thence, by the staircase, to the door of the building; for the egress of foul air there is a copper chimney (also with cowl at top, which can be turned away from the wind,) the lower end of which opens into the room at the ceiling, and branch pipes of zinc lead by means of a single connecting pipe into this chimney from above the several lamp flames, so as to carry off the smoke; since May 1870 there has also been a tall copper chimney with a stove at its foot (out of doors), and opening into the room at the ceiling, so that on lighting a fire in the stove, which is done daily, a draught is created causing foul air, by which alone it can be fed, to flow out of the room. In the original arrangement the zinc pipe connecting the branches proceeding to the lamps with the copper chimney entered the mouth of the latter without closing it, thus allowing the products of combustion from the lamps to fall back into the room. The object of this arrangement was to allow the egress of foul air from the room as well as from the lamps, but the former purpose being, since 1870, sufficiently served by the stove chimney, and the closing of the aperture between the zinc pipe and the other chimney being thus no longer objectionable, a conical piece of zinc was in 1872, fixed so as to effect the closure, and since then the ventilation of the room has been much improved. A further addition to the ventilating arrangements was made in 1881 with the special object of supplying,

when unobjectionable, a continuous stream of fresh air to the box in which the photographic papers are exposed; to effect this a piece of zinc pipe was inserted into the first-mentioned inlet-pipe near the ceiling, and the other end was supported over the middle of the apparatus box, which is connected and disconnected at will by means of a sliding vertical tube. Since these additions were provided, it has been a daily practice to admit fresh air into the room, during the night hours, exclusively through the apparatus box, and to close the passage in this direction, during the day hours, and open the inlet-pipe near the floor of the room. When the underground room is filled with a warm damp atmosphere, as in the months before the commencement of the monsoon, the sensitiveness of the photographic papers undergoes a serious deterioration during the exposure, and the formed images tend to fade away so that the earlier portions of the traces are feeble, whilst the later portions on the same sheet of paper are stronger: it was to mitigate these harmful influences that the special ventilation of the apparatus box was resorted to.

6. The precaution was taken, before the roof of the building was put on, to fix an absolute direction line in the magnetograph room by means of horizontal ivory scales secured to the north and south walls. Six independent observations of *Polaris* gave, in January 1869, as the direction joining the divisions + 35 on the north scale and + 6 on the south scale N. 14° 15′ 2″ W., with an average deviation from this direction of the single determinations of 23″. The pillars of the instruments are of Porbandar stone, and to the tops of them were cemented the marble slabs which form the basements of the several instruments: on these and through their centres straight lines were drawn, by reference to the datum just mentioned in the *true* directions N. 0° 58′ E. in the case of the declination instrument, and N. 89° 2′ W. in the case of the horizontal force instrument.

7. Observations of declination, dip and horizontal force were also made, in the roofless room, as follows:—

I. Of Absolute Declination.

By reference to the datum line in the magnetograph room.

Date.	Position of Instrument. Distance from Wall. East.	Position of Instrument. Distance from Wall. South.	Height above floor.	In Magnetograph room.	In Electrometer Tower at same time. Deduced from absolute observations and readings of Grubb's Declination Magnetometer.	Excess in Magnetograph room.
	Ft.	Ft.	Ft.	° ′ ″	° ′ ″	′ ″
1869 February 5 ...	3·2	14·9	4·6	N 1 2 49 E	N 0 47 18 E	+ 15 31
„ „ 6 ...				N 1 2 0 E	N 0 47 18 E	+ 14 42
„ May 11 ...	8·9	13·2	4·6	N 0 52 0 E	N 0 47 4 E	+ 4 56
„ „ 11 ...				N 0 51 29 E	N 0 47 37 E	+ 3 52
„ „ 12 ...				N 0 55 50 E	N 0 50 26 E	+ 5 24

The materials excavated to clear the space for the underground magnetograph room were red soil and boulders of trap rock, the latter of which were sensibly magnetic. The influence of similar boulders in the ground surrounding the building is apparent in the excess of the declination in the room over that found 38 feet above the ground surface being greater according as the place of observation is further from the middle of the room or nearer to the walls.

II. Of Dip.

8. With Barrow's dip circle No. 49 and Barrow's 3½-inch needles.

Date.	Needle No.	Dip.
		° ′
1869 February 4	1	18 57·1
„ „ 4	2	18 45·3
„ May 12	2	18 49·7
„ „ 13	2	18 54·1
„ „ 14	2	18 54·3

The positions of the instrument in the room were not recorded. The means of the observations of dip taken in the Electrometer Tower in the months of February and May 1869 were 19° 4′·8 and 19° 6′·2 respectively.

9. III. Of Horizontal Force.

Date.	Position of Instrument. Distance from Wall. East.	Position of Instrument. Distance from Wall. South.	Height above floor.	Horizontal Force, in British Units. In Magnetograph room.	Horizontal Force, in British Units. In Electrometer Tower at same time. Deduced from absolute observations and readings of Grubb's Horizontal Force Magnetometer.	Horizontal Force, in British Units. Excess in Magnetograph room.
1869 February 1—2 ...	...	...	...	8·1126	8·0711	+ ·0415
„ May 8 ...	8·9	12·8	4·6	8·0932	8·0537	+ ·0395
„ May 10 ...				8·0993	8·0560	+ ·0433
1870 October 17 ...	In lobby of magnetograph room.		4·6	8·1981	8·0654	+ ·1327

Here again the excess is larger in the small room, the walls of which are nearer to the instrument, than in the larger room, in consequence—doubtless—of the presence of magnetic rock in the enveloping ground.

10. In the Introduction to the "Bombay Magnetical and Meteorological Observations, 1865 to 1870," will be found on pages xxxiii to xlviii a description of the method of determining the absolute horizontal force, of the formula of reduction, and of the nomenclature adopted. The following are the data, according to this nomenclature, used in calculating the values of the horizontal force given in the above table:—

Table IV.

Date.	1869. Feb. 1.	1869. Feb. 2.	1869. May 8.	1869. May 8.	1869. May 10.	1869. May 10.	1870. Oct. 17.	1870. Oct. 17.
Civil Time	h. m. 7 42	h. m. 7 24	h. m. 13 29	h. m. 16 20	h. m. 12 31	h. m. 15 8	h. m. 13 39	h. m. 16 29
Observer	F.C.	C.G.T.	F.C.	F.C.	R.S.M.	R.S.M.	C.G.T.	C.G.T.
Grubb's Horizontal Force Magnetometer ... ...(D)	24·98	25·16	23·12	22·97	23·52	23·21	23·72	23·41
Do. ... ...(V)	24·65	24·82	23·68	22·74	23·49	22·74	24·39	23·30
Do. Scale coefficient = ·012								
Do. Thermometer ...(D)	78·1	77·2	88·0	88·0	88·5	88·7	86·7	84·6
Do. do. ...(V)	78·2	77·7	87·6	87·9	88·0	88·5	86·3	86·0
Do. Effect of 1° of temperature = —·015 sc. div.								
t_d	75·5	74·0	86·7	86·8	84·9	85·1	88·8	87·7
t_o	72·2	70·9	86·0	85·8	84·7	85·0	91·5	91·4
T_o	2·66528	2·66541	2·67750	2·67967	2·67833	2·67953	2·7049	2·7070
Effect of 90° of torsion (sc. div.) ...	0·63	0·65	0·22	0·28	0·28	0·29	0·74	0·74
One scale division of magnet N. 23 a = 2·23′.								
s	+ 3·3	+ 3·4	+ 0·8	+ 0·8	—0·9	—0·9	—1·7	— 1·7
For r_o = 0·8 foot ... ... u =	° ′ ″ 19 58 37	° ′ ″ 19 59 18	° ′ ″ 19 52 20	° ′ ″ 19 52 23	° ′ ″ 19 49 6	° ′ ″ 19 49 19	° ′ ″ 18 56 33	° ′ ″ 18 57 2
For r_o = 1·0 foot ... ... u' =	10 5 38	10 7 16	10 3 51	10 4 3	10 3 26	10 3 24	9 36 56	9 36 39
K′ = 4·2004								
r_d = + 2″·0								
r_o = + 1″·1								
A = 1·61751								
$B_{r=\delta}$ = 9·41246								
$B_{r=0}$ = 9·70144								
P = —·00634								
q = ·000188								
q' = ·000,000,112								
θ_t = ·000,223								
a, a' always less than 1°								
X ...	8·1159	8·1093	8·0969	8·0895	8·1011	8·0975	8·2009	8·1954
Mean X ...	8·1126		8·0932		8·0993		8·1981	

11. The barograph was placed in the room, in such a position that its temperature compensation bars should lie midway between the two force magnetometers, so that it should afford a record of the variations of temperature of those instruments. Tabulations from the temperature curves of the barograph registration papers, read off to 0°·2, gave, for the months October to December 1876, mean diurnal variations of the temperature of the instrument of the characters indicated by the following numbers:—

TABLE V.

1876.	h. m. 0 7	h. m. 1 7	h. m. 2 7	h. m. 3 7	h. m. 4 7	h. m. 5 7	h. m. 6 7	h. m. 7 7	h. m. 8 7	h. m. 9 7	h. m. 10 7	h. m. 11 7	h. m. 12 7	h. m. 13 7	h. m. 14 7	h. m. 15 7	h. m. 16 7	h. m. 17 7	h. m. 18 7	h. m. 19 7	h. m. 20 7	h. m. 21 7	h. m. 22 7	h. m. 23 7
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
October ...	−·02	·00	·00	−·04	−·04	−·06	−·04	−·08	−·04	·00	+·08	+·10	+·04	+·06	+·02	+·04	+·04	+·02	·00	−·02	+·02	·00	·00	+·02
November ...	+·02	+·02	+·04	+·02	·00	+·02	+·02	−·02	−·02	+·04	+·10	+·14	+·06	+·04	+·02	−·02	−·04	−·06	−·06	−·08	−·12	−·08	−·08	−·04
December ...	−·04	−·08	−·04	−·02	−·02	·00	−·02	−·04	+·02	·00	·00	+·06	·00	+·08	·00	·00	+·04	+·04	+·02	+·04	·00	−·02	·00	+·02
Mean ...	−·01	−·02	·00	−·01	−·02	−·01	−·01	−·05	−·01	+·01	+·06	+·10	+·03	+·05	+·01	+·01	+·01	·00	−·01	−·02	−·03	−·03	−·03	·00

And the mean diurnal variations of the readings of the thermometer attached to the barograph are, for the same months, as follows:—

TABLE VI.

1876.	h. m. 6 20	h. m. 10 20	h. m. 14 20	h. m. 16 20	h. m. 22 20
	°	°	°	°	°
October ...	−·01	+·24	−·09	−·11	+·05
November ...	−·06	+·21	−·06	−·10	+·01
December ...	−·05	+·11	−·06	−·05	+·03
Mean ...	−·04	+·19	−·07	−·09	+·03

Also, for the same months, the mean diurnal variations of the readings of the thermometer enclosed with the vertical force magnetograph are:—

TABLE VII.

1876.	h. m. 6 17	h. m. 10 17	h. m. 14 17	h. m. 16 17	h. m. 22 17
	°	°	°	°	°
October ...	−·02	+·22	−·06	−·13	−·01
November ...	−·07	+·22	−·04	−·07	−·03
December ...	−·06	+·18	−·01	−·06	−·07
Mean ...	−·05	+·21	−·04	−·09	−·04

12. To obtain the angular values of a division of the scale attached to the reading telescope and of an inch of ordinates of the magnetograph curves, the following measurements were made:—

Distances from backs of mirrors attached to magnets to telescope scales are—

Of Declination = 42·56; of Horizontal Force = 41·67; and of Vertical Force = 65·05 inches.

Thickness of all the mirrors = 0·115 inch.

Thickness of glass plates in sides of gun-metal cylinders = 0·18 inch.

Whence, taking 1·5 for the refractive index of the glasses, and reducing each number by ·01 on account of the angle subtended at the mirror by the telescope and scale, the virtual distances are—

Of Declination 42·45; of Horizontal Force 41·56; and of Vertical Force 64·94 inches.

Similarly the distances from backs of mirrors to the recording cylinders are—

Of Declination 60·25; of Horizontal Force 60·26; and of Vertical Force 60·08 inches.

Thickness of hemi-cylindrical lenses = 0·60 inch; whence, with thickness of mirrors and glass plates as above, the virtual distances are—

Of Declination 59·95; of Horizontal Force 59·96; and of Vertical Force 59·78 inches.

The ivory telescope scales being circular in form, and the chord of an arc of 50 divisions measuring 10·00 inches, we have, for the angular movement of the magnet corresponding to a change of unity in the scale reading—

$$\tfrac{1}{50}^{\text{th}} \text{ of } \mathrm{Sin}^{-1} \frac{5}{\text{virtual distance}}$$

and, multiplying the declination value by the torsion coefficient (1·0016) of the suspension thread, we obtain—

For the Declination	8′·13 or ·002365
for the Horizontal Force	8·29 or ·00241
and for the Vertical Force	5·30 or ·00154.

And, for the angular movement of the magnet, *per* inch of increase of the ordinates of the curves, we have, when the movement is small, (say)

1000 times $\mathrm{Sin}^{-1} \frac{\cdot 001}{\text{Twice the virtual distance}}$, that is—after multiplying, in the case of the declination instrument, by 1·0016 the torsion coefficient—

For the Declination	28′·72 or ·00835
for the Horizontal Force	28·67 or ·00834
and for the Vertical Force	28·75 or ·00836

13. It will be convenient to give here the converting factors for changing scale-readings into ordinates and *vice versâ*. These are,

TABLE VIII.

	To change scale-readings into ordinates.	To change ordinates into scale-readings.
Declination	$\frac{\cdot 002365}{\cdot 00835} = \cdot 283$	3·53
Horizontal Force ...	$\frac{\cdot 00241}{\cdot 00834} = \cdot 289$	3·46
Vertical Force	$\frac{\cdot 00154}{\cdot 00836} = \cdot 184$	5·43

14. The scales of the three instruments, as well as the thermometers and vacuum gauges in the enclosures of the two force instruments, have been read four or five times a day, as follows:—

in 1870 and 1871..... about the civil hours 8, 10, 12, 14 and 16
in 1872..... about the civil hours 6, 10, 14 and 16
and from 1873·0 onward..... about the civil hours 6, 10, 14, 16 and 22,

the minute of reading having always been

for the Declination	18 after the hour
for the Horizontal Force	19 after the hour
and for the Vertical Force	17 after the hour

except before the 29th March 1871 when they were 12, 14 and 10 minutes after the hour respectively.

15. Maximum and minimum thermometers, a pair of which is exposed to the air of the room, are read once a day.

16. Fresh sensitive papers are generally put upon the recording cylinder of the three magnetographs every two days, but on occasions when difficulty has been experienced in obtaining distinct photographic traces of the movements of the magnets, the papers have been changed daily or even oftener. The time at which the cylinders are put forward daily is about

9 hours 28 minutes, and the average time occupied in changing the papers is about 9 minutes and that occupied—on alternate days—in shifting the cylinders only is about 4 minutes.*

17. Hourly tabulations are made of the ordinates of the magnetograph curves at the same minutes (17, 18 and 19) after the hour as those on which the scale-readings are taken; they are read off at once, in true inches, by means of a tabulating instrument designed originally by Mr. Robert Beckley and improved by Mr. G. M. Whipple, and are entered on monthly abstracts, and on these the monthly means are calculated for each hour. A day's tabulations begin with 10 hours and end with 9 hours, these being the first and last full hours that appear on each registration paper. As the daily ranges of temperature of the instruments, as indicated by the examples included in the tables of paragraph 11, are only a few tenths of a degree, the tabulations of the two force instruments are dealt with, in the first place, as if free from temperature effect; the extent to which the results obtained are vitiated by this procedure will, therefore, require consideration at a later stage.

NEW THEORY OF THE VERTICAL FORCE MAGNETOMETER, WITH AN APPLICATION TO THE CASE OF THE COLA'BA VERTICAL FORCE MAGNETOGRPH.

18. In the generally accepted theory of the vertical force magnetometer it is assumed that the knife-edge of the magnet is a mathematical straight line, a consequence of which is that the coefficient should not vary sensibly with change of scale-reading, *i.e.* with the position of the magnet: it is also assumed that the coefficient is—within practical limits of temperature—the same for all temperatures; but both these assumptions are far from being allowable with respect to the Colába vertical force magnetograph. It would come to the same thing in respect to the first assumption if the curvature of the surface of the knife-edge, being sensible, were also uniform, but this too is an inadmissible assumption in respect of the Colába instrument as its behaviour—to be now described—will clearly show. In the report of this Observatory for 1871-72 it was mentioned that the agate knife-edge was shown, by inspection, to be sensibly curved, with an estimated radius of curvature of ·006 inch; and also that within the range (of about 4°) of the scale-readings of the instrument the sensitiveness varied so as to be twice as great at the extreme ends of the scale as in the middle, and this when the absolute retaining force in the middle position had been made as great as the horizontal force at Colába, *i.e.* about 8·0 British units of force. From the first (in 1869) it had been observed also that if the sensitiveness were made much greater than this, the magnet became an oversetting balance, on both sides, whenever the disturbance from the middle position of adjustment reached (say) 2°; and the deflection experiments (to be hereafter described) of February 8-9, and April 11, 1872, September 12, 1873, and July 5, 1882, indicate an even worse result than the above, viz.;—that the diminution of the scale-coefficient due to a change of 10 divisions of the scale from the middle position (about 33) is (roughly) ·002 *mm.—mg.—s.* unit of force.

19. Let us now see in what way the theory of the instrument must be modified if we suppose that the curvature of the knife-edge increases on both sides of the middle line of support as it would do if its section (at right angles to the knife-edge) had the form that an ellipse has at the extremity of its shorter axis.

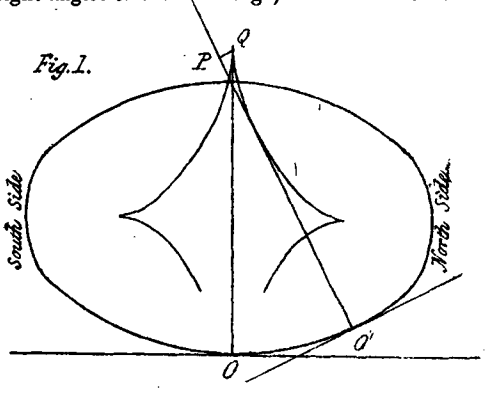


Fig. 1.

When the knife-edge rests upon the plane in its middle position O (OQ being the radius of curvature of O) let the centre of gravity of the mass of the magnet and its attachments, when in adjustment, lie at a distance a to south-ward of Q and at a distance b below Q: then we have the ordinary equations—

$$Wga = mY_o, \text{ and } mXd_a + Wgbd_a = mdY_o$$

Where W is the mass of the magnet and attachments, g is the force of gravity, m is the magnetic moment of the vertical force magnet, Y_o is the vertical magnetic force and X is the horizontal magnetic

* Latterly these times have been reduced to about 6 and 2 minutes.

force of the Earth, and α is the inclination of the line $O\,Q$ to south of the vertical: but if the system roll on the knife-edge till O' is in contact with the horizontal plane, a new moment will be brought into play tending to increase the roll; the normal $O'P$ being a tangent to the evolute will have the point Q to the right of it and the new moment will be $Wg\,(PQ)$—PQ being the distance of the point Q from the line $O'P$.

The equation to the normal to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at the point x', y' is

$$y - y' = + \frac{a^2}{b^2}\frac{y'}{x'}(x - x') \qquad (a)$$

and the distance of the point x'', y'' from the straight line $y = cx + d$ is

$$PQ = \frac{y'' - cx'' - d}{\sqrt{c^2 + 1}} \qquad (b)$$

Of the point Q the co-ordinates are $x'' = o$; $y'' = \frac{a^2}{b} - b$

and from (a) $c = + \frac{a^2}{b^2}\frac{y'}{x'}$ and $d = y' - \frac{a^2}{b^2}y' = y'\left(1 - \frac{a^2}{b^2}\right)$, whence

$$PQ = \frac{\frac{a^2}{b} - b - y'\left(1 - \frac{a^2}{b^2}\right)}{\sqrt{\frac{a^4}{b^4}\frac{y'^2}{x'^2} + 1}} = \frac{\left(\frac{a^2}{b^2} - 1\right)(b + y')}{\frac{a^2}{b^2}\frac{y'}{x'}\sqrt{1 + \frac{b^4}{a^4}\frac{x'^2}{y'^2}}} = \left(\frac{a^2}{b^2} - 1\right)(b + y')\frac{b^2}{a^2}\frac{x'}{y'} \qquad (c)$$

nearly, since

$\frac{b^2}{a^2}\frac{x'}{y'}$ is the tangent of the small angle α (see equation (a) above) and, therefore, its square or α^2 may be neglected beside unity. Now $y' = \frac{-b}{a}(a^2 - x^2)^{\frac{1}{2}} = -b\left(1 - \frac{1}{2}\frac{x^2}{a^2}\right)$ when $\frac{x}{a}$ is a small fraction, and $b + y' = \frac{1}{2}b\frac{x'^2}{a^2}$; whence (c) becomes $\qquad (d)$

$$PQ = \tfrac{1}{2}\left(\frac{a^2}{b^2} - 1\right)\frac{x'^2}{a^2}b\left(\frac{b^2}{a^2}\frac{x'}{y'}\right):$$

and as $\alpha = \frac{b^2}{a^2}\frac{x'}{y'}$ or $x' = \frac{a^2}{b^2}y'\alpha$ nearly

$$PQ = \tfrac{1}{2}\left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b^2}y'^2\alpha^2 = \tfrac{1}{2}\left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b}\alpha^2 \text{ nearly, since } y'^2 = b^2 \text{ nearly}$$

Hence the new moment is $\frac{1}{2}Wg\left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b}\alpha^2$, and

$$\frac{1}{m}Wg\frac{d(PQ)}{d\alpha} = \frac{3}{2}\frac{W_g}{m}\left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b}\alpha^2, \qquad (e)$$

or the additional coefficient varies as α^2

20. Now in January 1880, or before, observations or experiments gave the following values. $W = 1760{\cdot}1$ grains, $g = 32{\cdot}19$, $Wg = 56657{\cdot}6$, $m = 0{\cdot}5907$, all in British units, and the factor for converting British units of magnetic force into $(mm—mg—s)$ units is $0{\cdot}46108$. One division of the vertical force magnetograph scale = ·00154 or 10 scale-divisions = ·0154. Hence, the case described in paragraph 18 gives for insertion in equation (e)

$$\cdot5907 \times \frac{\cdot002}{\cdot46108} = \frac{3}{2} \times 56657{\cdot}6\left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b} \times (\cdot0154)^2 = \left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b} \times 84986{\cdot}4 \times \cdot00023716$$

$$\cdot5907 \times \cdot000215 \text{ foot} = \left(\frac{a^2}{b^2} - 1\right)\frac{a^2}{b}$$

$$\cdot5907 \times \cdot00258 \text{ inch} = \cdot00152 = \left(\frac{a^2}{b} - 1\right)\frac{a^2}{b}$$

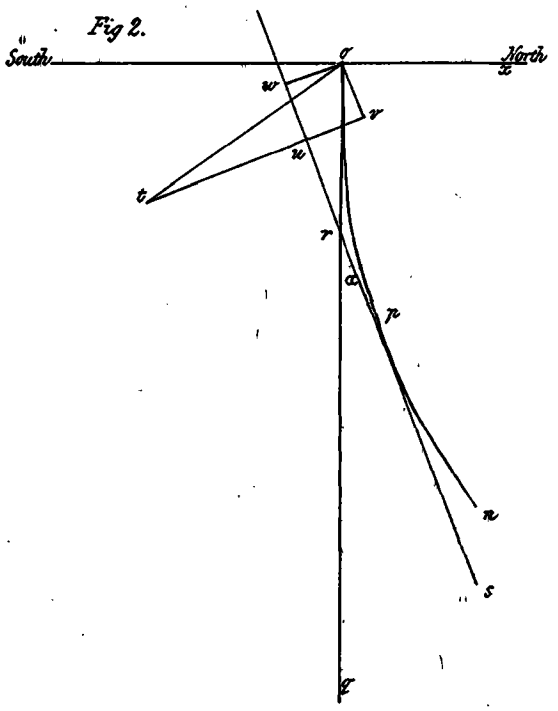
If we suppose $\frac{a}{b} = 1{\cdot}1$ this gives $a = \cdot0066$ } whence a value of $\frac{a}{b}$ between $1{\cdot}1$ and
and if " " $= 1{\cdot}2$ " " $= \cdot0029$ } $1{\cdot}2$ and near to $1{\cdot}1$ will give $a = \cdot006$ inch. That is to say, if we suppose the small part of the knife-edge brought into use within the range of the scale (less than half a thousandth of an inch) to be a bit of the

broad side of an ellipse whose axes are ·006 inch and between ·005 and ·0055 inch, the behaviour of our instrument would be to a great extent explained; and within the range of the scale the magnet would become an oversetting balance unless the coefficient for the middle position exceeded ·002 $(\frac{25}{16})^2$ or ·0125. It did not, however, in fact overset within a greater range than this when the coefficient was as small as about ·008, so the assumption that the curvature of the knife-edge is elliptical although accounting roughly for the general facts is not suited for rigorous adoption.

21. But having now ascertained that this effect is of the right order of magnitude, we may reverse the process and construct from actual variations of scale reading under the action of known disturbing forces the curve of the knife-edge on an enlarged scale. The curve may be any orthogonal line to the series of normals drawn through the successive points marking the values of PQ for different scale-readings providing that such orthogonal line cuts none of the normals above their points of contact with the evolute to the curve. In this way we find by experiment that the curvature of the knife-edge of the Colába vertical force magnetograph is a minimum at that part which rests on the agate plane when the scale-reading is 33·2 (about)—the relative positions of the magnet, the mirror attached to it, the scale, and the reading telescope* having been the same throughout the period considered—and the curvature increases continuously though not symmetrically on both sides of this position, and consequently the evolute to the curve has a cusp on the normal to the point of minimum curvature and has branches on each side that are convex towards that line.

Suppose $o\ p\ n$ (fig. 2) to be a representation (exaggerated in order that it may be distinctly seen) of one side of the evolute on a plane section perpendicular to the knife-edge, the cusp being at the point o, through which passes $q\ o$ the normal to the knife-edge drawn from its point of minimum curvature: let $s\ p\ w$, touching the evolute at p, be the normal to the point of the curve of the knife-edge on which the magnet is supposed to be resting under the influence of a deflector magnet: $s\ p\ w$ will necessarily be vertical, since the agate plane on which the magnet rests, being a tangent plane, is horizontal: let the angle $q\ r\ s$ which $q\ o$ makes with $s\ p\ w$ be α, and—t being the centre of gravity of the magnet and its attachments—let the distance $t\ o = c$; and—$x\ o$ being perpendicular to $q\ o$—let the angle $x\ o\ t$ be called ϵ:

Fig 2.



*On the 7th February 1879 the reading-telescope was unclamped from its frame and moved laterally, and it was then put back and re-clamped: it is believed that there was no change of elevation of the telescope that need here be regarded. The change of scale reading from 10 hours to 14 hours of that day was a fall of 0·44, the usual change being a rise of about 0·12.

also let a_0 be the north dip of the magnetic axis of the magnet when $q\ o$ is vertical. Further let us define as follows :—

X = the horizontal magnetic force of the Earth.*

Y_0 = the vertical magnetic force of the Earth.

y = the vertical magnetic force produced by the presence of the deflector magnet.

m = the magnetic moment of the vertical force magnet.

W = the mass of the magnet and its attachments.

g = the force of gravity.

Then, $t\ v$ and $w\ o$ being perpendicular, and $v\ o$ parallel, to $s\ p\ w$, the equation of equilibrium is—

$$m\,(Y_0 + y)\cos(a_0 + a) - m\,X\sin(a_0 + a) - W_g\,(t\,u) = o \qquad (1)$$

or as $(a_0 + a)$ is a small angle, and $t\,u = t\,v - w\,o = -c\cos(\epsilon + a) - w\,o$.

$$(Y_0 + y) - X(a_0 + a) + \frac{W_g}{m}\,c\cos(\epsilon + a) + \frac{W_g}{m}(w\,o) = o. \qquad (2)$$

When $a = o$ this expression becomes—

$$Y_0 - X a_0 + \frac{W_g}{m}\,c\cos\epsilon = o \qquad (3)$$

Subtracting which from (2), we have—

$$y - X a - \frac{W_g}{m}\,c\sin\epsilon \times a + \frac{W_g}{m}(w\,o) = o, \text{ nearly, whence} \qquad (4)$$

$$\frac{W_g}{m}(w\,o) = \left(X + \frac{W_g}{m}\,c\sin\epsilon\right)a - y \qquad (5)$$

$$w\,o\dagger = \left(\frac{m}{W_g}\,X + c\sin\epsilon\right)a - \frac{m}{W_g}\,y, \text{ and differentiating (4) with respect to } a \qquad (6)$$

$$\frac{dy}{da} = \left(X + \frac{W_g}{m}\,c\sin\epsilon\right) - \frac{W_g}{m}\,\frac{d\,(wo)}{da} \qquad (7)$$

22. It would render the instrument practically useless if a were allowed to become so large as to make the variations [(say) diurnal] of X a consideration in this regard, that is to say—if it were such as to make $a\,dX$ a quantity not of a lower order than, but of the same order as, dY; and this is of the greater importance in a low magnetic latitude where the diurnal range of the horizontal force greatly exceeds that of the vertical force. For this among other reasons care has been taken never to allow the vertical force magnet at Colába to deviate largely from the horizontal direction,—the means of control devised having been those that will now be described. It was found that when the magnet was supported upon its lifters, and adjusted to horizontality by means of a small level resting upon its edge, the mirror should be adjusted to read 29·55 (approximately) in order that its normal should also be horizontal. On the 4th February 1872 it was adjusted to 29·85, and on the 28th January 1880—the mirror having been accidentally moved two days before—it was again set at 28·62. On the 11th January 1881, after a new adjustment of the instrument, the mirror was found at 28·99 when the magnet was horizontal. The greatest scale reading on the records of May 1872 to June 1882 is 38·26, which, taking 29·55 as corresponding to the zero value of a, gives $a = (38{\cdot}26 - 29{\cdot}55) \times 5'{\cdot}30 = 46'$ (about) or $\sin a = {\cdot}014$: the average diurnal range of the horizontal force is about ·006 units of force, and ·014 of this is about ·00008, or about double the limit of accuracy of measurement of the vertical force magnetograms; and this is of course an extreme case. The least reading on the same records is 24·10 and would give less than ·00006 as the greatest effect of the diurnal variation of horizontal force.

23. Now the relation of $w\,o$ to a being purely geometrical, the values of wo given by equation (6) should be the same, however the terms on the right hand side may vary

*Magnetic force will, in these investigations, always be expressed in millimetre-milligramme-second units, except when an express statement is made to the contrary. But as all our weighings and measurings are made with instruments adapted to the British system, it will be convenient when these enter into equations along with forces to convert the latter into British measure by dividing by ·46108.

†Though scarcely necessary, it may be remarked that when a is negative wo will also be affected with the negative sign.

amongst themselves, so long as the relative positions of the magnet, the mirror attached, the scale, and the reading telescope remain the same. Hence although c, ϵ, m, W and X may vary, we are at liberty to combine values of $(w\ o)$ obtained from the data given by different sets of experiments, a matter of some importance arising from the fact that single determinations are subject to considerable probable errors. Similarly we may combine values of $\frac{W_g}{m}\ (w\ o)$ given by equation (5) if we are careful to regard the result as affected by some mean value of $\frac{W_g}{m}$.

24. It will render the equations (4), (5), (6) and (7) more convenient for practical use if, in them, we substitute for y and α equivalents in terms of other quantities. As it will be quite by accident if the initial position of the vertical force magnet, in any set of experiments, is that which places qo vertical, let the disturbing force, which will be *zero* for the actual initial position, be called Y and let the force necessary to bring qo into the vertical position be $Y_,$; then we must substitute $Y-Y_,$ for y in the equations. Also calling the angular value of a division of the vertical force magnetograph scale a—at Colaba $a = 00154$—and the scale-reading s, we may write $a\ (s-33{\cdot}2)$ for α or $as-33{\cdot}2\ a$: and for $\left(X + \frac{W_g}{m}\ c\ \sin\epsilon\right) 33{\cdot}2\ a$, which is practically constant during a single set of experiments we may write C. The equations then become—

$$Y - Y_, = \left(X + \frac{W_g}{m}\ c\ \sin\epsilon\right) as - C - \frac{W_g}{m}\ (wo) \qquad (4a)$$

$$\frac{W_g}{m}\ (wo) = \left(X + \frac{W_g}{m}\ c\ \sin\epsilon\right) as - Y - (C - Y_,) \qquad (5a)$$

$$(wo) = \left(\frac{m}{W_g}\ X + c\ \sin\epsilon\right) as - \frac{m}{W_g}\ Y - \frac{m}{W_g}\ (C - Y_,) \qquad (6a)$$

$$\frac{d\ Y}{d\ s} = \left(X + \frac{W_g}{m}\ c\ \sin\epsilon\right) a - \frac{W_g}{m}\ \frac{d\ (w\ o)}{d\ s} \qquad (7a)$$

25. Y has been defined as the vertical magnetic force produced by the presence of a deflector magnet. This magnet is a solid cylinder, 4·04 inches long, and is marked $E\ 1$: it is placed successively at different distances from the knife-edge of the vertical force magnet with its middle point on a horizontal line that intersects the knife-edge at right angles and that lies in the plane of rotation of the magnetic axis of the vertical force magnet, first on the north side of the instrument and then on the south side; and at each distance on each side it is adjusted to verticality, and its effect is observed by reading the vertical force scale in each of four cases, viz.:—1st when the magnet is at the north side and its north end* is upward, 2nd when at the north side and north end downward, 3rd when at the south side and north end upward, and 4th when at the south side and north end downward. We thus obtain two series of values of s corresponding to two identical series of distances of the deflector magnet—one series of the former for which the deflector was on the north side and another for which it was on the south side of the instrument.

If the vertical force magnet were now suspended by a fine thread with its knife-edge vertical in continuation of the thread and the deflector magnet were turned to point east and west instead of up and down, the relation of the two magnets to each other would, as to position, be the same† at each distance, as in the deflection experiments just described; and the only difference between the two cases is that in the one the motions of the vertical force magnet are opposed by the horizontal magnetic force of the earth and in the other by an unknown force the value of which we seek to determine. It would make no difference either if another magnet of the same shape and dimensions as the vertical force magnet were substituted for the latter in making the experiments of deflection in the horizontal plane,—providing that the magnetism in the substituted magnet were distributed in the same manner as that in the vertical force magnet; and that this proviso is satisfied may be determined by comparing a pair of sets of experiments of deflections in the horizontal plane made, once for all, when the vertical force magnet and the substituted magnet are respectively suspended. If, moreover, the horizontal deflections are observed at a place for

* By north end of a magnet we shall always mean the end that, if the magnet were free, would point northward.

† Except for the slight deviation of the vertical force magnet from the north and south direction in the one case and from the horizontal direction in the other, and those deviations have too small effects to need consideration.

which the horizontal force is exactly known, their angular values, corrected for the torsion of the suspension thread, have only to be multiplied by the known horizontal force to obtain the values (Y) of the disturbing forces of the deflector magnet in its several positions. Such a place at Colába is the top of the pillar on which are made the regular observations of vibration and deflection for the determination of the horizontal force, and it has been used for the purpose described in all the experiments to be presently dealt with. The Colába magnet spoken of above as the substituted magnet is marked N3.

26. In the practice of magneticians at the present day, pairs of deflections giving the disturbing forces Y_+ and Y_- as corresponding to the scale-readings of the vertical force magnetograph s_+ and s_-, are adopted as yielding values of $\frac{dY}{ds}$ $\left(=\frac{Y_+ - Y_-}{s_+ - s_-}\right)$ for each deflection distance, and such values for the several distances are combined to produce the coefficient which is to be adopted in the reduction of the registrations of the time near the date of the particular set of deflection experiments. A serious objection to this practice is that $\frac{dY}{ds}$ is not constant for a given time but varies materially with the scale-reading, and it is found, moreover, at Colába that individual values of Y are subject to such considerable probable errors that it is better to combine values—or for convenience their equivalent deflections—not only for several distances but also for experiments of different dates; and then to calculate the values that shall be used in combination with the several values of s to find a general value, for each set of experiments, of $\frac{dY}{ds}$. In fact it would seem that the probable error of a small deflection, such as all those dealt with in these experiments are, is about as great as that of a large angle such as that from which, in the regular deflection observations, the absolute value of the horizontal force is deduced. The mode of combination of the deflections in the horizontal plane will presently be described.

27. From what has been said the following tables will be understood without any further description than their headings and the notes to them afford.

TABLE 1.—*Experimental deflections of the Declination Magnetograph by the deflector Magnet E* 1.

(a) OBSERVATIONS.						(b) CALCULATION OF THE DOUBLE DEFLECTIONS.				
Number and date of experiment.	Local Time by Magnetograph Clock.	Declination Magnetograph. Scale reading.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Distance.	Means. Higher readings.	Means. Lower readings.	Difference or double deflection.	Value of one division of scale corrected for torsion.
	d. h. m.									
I.—9th February 1872.	9 15 25	24·05	Away.		C. C.	3·0	25·29	22·865	2·425	8″·13
	„ „ 39	22·85	3·0 N.	E.	C. C.	2·5	26·19	21·98	4·21	
	„ „ 42	21·97	2·5 N.	E.	C. C.	2·0	28·23	19·94	8·29	
	„ „ 47	19·93	2·0 N.	E.	C. C.	1·7	30·93	17·22	13·71	
	„ „ 51	17·21	1·7 N.	E.	C. C.					
	„ „ 56	30·88	1·7 N.	W.	C. C.					
	„ 16 19	30·90	1·7 N.	W.	C. C.					
	„ „ 23	28·22	2·0 N.	W.	C. C.					
	„ „ 26	26·19	2·5 N.	W.	C. C.					
	„ „ 28	25·29	3·0 N.	W.	C. C.					
	„ „ 30	25·29	3·0 S.	W.	C. C.					
	„ „ 33	26·19	2·5 S.	W.	C. C.					
	„ „ 35	28·24	2·0 S.	W.	C. C.					
	„ „ 38	30·97	1·7 S.	W.	C. C.					
	„ „ 41	17·23	1·7 S.	E.	C. C.					
	„ „ 44	19·95	2·0 S.	E.	C. C.					
	„ „ 47	21·99	2·5 S.	E.	C. C.					
	„ „ 49	22·88	3·0 S.	E.	C. C.					
	„ „ 50	24·08	Away.	—	C. C.					

TABLE 2.—*Experimental deflections of the Magnet N 3, suspended in the Electrometer Tower, by the deflector Magnet E 1.*

OBSERVATIONS.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
II.—12th April 1872.	12 14 22	14·12	88·0	Away.	...	C. C. and V. N.
	,, ,, 27	13·35	...	3·0 S.	E.	
	,, ,, 28	13·18	...	2·8 S.	E.	
	,, ,, 30	12·96	...	2·6 S.	E.	
	,, ,, 38	13·02	...	2·6 S.	E.	
	,, ,, 41	11·73	88·2	2·0 S.	E.	
	,, ,, 44	8·35	...	1·5 S.	E.	
	,, ,, 47	2·45	...	1·2 S.	E.	
	,, ,, 52	25·70	...	1·2 S.	W.	
	,, ,, 54	19·77	...	1·5 S.	W.	
	,, ,, 58	16·38	...	2·0 S.	W.	
	,, 15 1	14·73	...	3·0 S.	W.	
	,, ,, 4	14·72	87·9	3·0 N.	W.	
	,, ,, 7	16·36	...	2·0 N.	W.	
	,, ,, 9	19·78	...	1·5 N.	W.	
	,, ,, 11	25·65	...	1·2 N.	W.	
	,, ,, 17	2·39	...	1·2 N.	E.	
	,, ,, 22	8·27	87·7	1·5 N.	E.	
	,, ,, 25	11·71	...	2·0 N.	E.	
	,, ,, 28	13·37	...	3·0 N.	E.	
	,, ,, 30	14·04	88·0	Away.	...	
III.—10th September 1873.	10 8 18	14·10	83·8	Away.	...	P. and N. V.
	,, ,, 23	13·52	83·8	3·0 S.	E.	
	,, ,, 28	12·05	83·8	2·0 S.	E.	
	,, ,, 36	9·05	83·8	1·5 S.	E.	
	,, ,, 44	3·48	83·9	1·2 S.	E.	
	,, ,, 52	24·43	83·9	1·2 S.	W.	
	,, ,, 57	19·03	83·9	1·5 S.	W.	
	,, 9 2	15·96	83·9	2·0 S.	W.	
	,, ,, 7	14·50	83·9	3·0 S.	W.	
	,, ,, 10	14·49	83·9	3·0 N.	W.	
	,, ,, 13	15·85	83·9	2·0 N.	W.	
	,, ,, 17	18·62	84·0	1·5 N.	W.	
	,, ,, 20	23·31	84·0	1·2 N.	W.	
	,, ,, 24	4·43	84·0	1·2 N.	E.	
	,, ,, 28	9·21	84·1	1·5 N.	E.	
	,, ,, 33	11·99	84·1	2·0 N.	E.	
	,, ,, 37	13·31	84·1	3·0 N.	E.	
	,, ,, 41	13·89	84·1	Away.	...	
IV.—13th September 1873.	13 18 28	13·97	84·5	Away.	...	P.
	,, ,, 29	13·96	84·5	,,	...	V.N.
	,, ,, 34	12·76	...	2·4 S.	E.	P.
	,, ,, 35	12·75	...	,,	,,	V.N.
	,, ,, 39	11·87	...	2·0 S.	,,	P.
	,, ,, 40	11·88	...	,,	,,	V.N.
	,, ,, 42	11·08	...	1·8 S.	,,	P.
	,, ,, 43	11·09	...	,,	,,	V.N.
	,, ,, 45	16·79	...	1·8 S.	W.	P.
	,, ,, 46	16·79	...	,,	,,	V.N.
	,, ,, 48	16·00	...	2·0 S.	,,	P.
	,, ,, 49	16·01	...	,,	,,	V.N.
	,, ,, 51	15·05	84·6	2·4 S.	,,	P.
	,, ,, 52	15·06	84·6	,,	,,	V.N.
	,, ,, 54	15·00	84·6	2·4 N.	,,	P.
	,, ,, 55	15·00	84·6	,,	,,	V.N.
	,, ,, 57	15·82	...	2·0 N.	,,	P.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
V.—1st July 1876.	13 18 58	15·84	...	2·0 N.	W.	V.N.
	,, 19 0	16·56	...	1·8 N.	,,	P.
	,, ,, 1	16·57	...	,,	,,	V.N.
	,, ,, 3	11·27	...	1·8 N.	E.	P.
	,, ,, 4	11·26	...	,,	,,	V.N.
	,, ,, 6	12·00	...	2·0 N.	,,	P.
	,, ,, 7	12·01	...	,,	,,	V.N.
	,, ,, 9	12·80	...	2·4 N.	,,	P.
	,, ,, 10	12·81	...	,,	,,	V.N.
	,, ,, 13	13·93	84·6	Away.	...	P.
	,, ,, 14	13·94	84·6	,,	...	V.N.
	1 17 52	14·06	88·8	Away.	...	P.
	,, ,, 53	14·06	88·8	,,	...	V.N.
	,, ,, 58	12·91	...	2·4 S.	E.	P.
	,, ,, 59	12·90	...	,,	,,	V.N.
	,, 18 1	12·05	...	2·0 S.	,,	P.
	,, ,, 2	12·05	...	,,	,,	V.N.
	,, ,, 3	11·31	...	1·8 S.	,,	P.
	,, ,, 4	11·29	...	,,	,,	V.N.
	,, ,, 6	16·70	...	1·8 S.	W.	P.
	,, ,, 7	16·70	...	,,	,,	V.N.
	,, ,, 9	15·95	...	2·0 S.	,,	P.
	,, ,, 10	15·95	...	,,	,,	V.N.
	,, ,, 12	15·10	88·9	2·4 S.	,,	P.
	,, ,, 13	15·10	88·9	,,	,,	V.N.
	,, ,, 16	15·17	88·9	2·4 N.	,,	P.
	,, ,, 17	15·19	88·9	,,	,,	V.N.
	,, ,, 19	15·93	...	2·0 N.	,,	P.
	,, ,, 20	15·92	...	,,	,,	V.N.
	,, ,, 22	16·66	...	1·8 N.	,,	P.
	,, ,, 23	16·66	...	,,	,,	V.N.
	,, ,, 26	11·36	...	1·8 N.	E.	P.
	,, ,, 27	11·36	...	,,	,,	V.N.
	,, ,, 29	12·14	...	2·0 N.	,,	P.
	,, ,, 30	12·14	...	,,	,,	V.N.
	,, ,, 33	12·89	...	2·4 N.	,,	P.
	,, ,, 34	12·88	...	,,	,,	V.N.
	,, ,, 37	14·02	89·1	Away.	...	P.
	,, ,, 38	14·01	89·1	,,	...	V.N.
	,, ,, 41	10·04	...	1·6 S.	E.	P.
	,, ,, 42	10·03	...	,,	,,	V.N.
	,, ,, 44	7·95	...	1·4 S.	,,	P.
	,, ,, 45	7·95	...	,,	,,	V.N.
	,, ,, 49	4·10	...	1·2 S.	,,	P.
	,, ,, 50	4·09	...	,,	,,	V.N.
	,, ,, 54	23·74	...	1·2 S.	W.	P.
	,, ,, 55	23·73	...	,,	,,	V.N.
	,, ,, 58	19·96	...	1·4 S.	,,	P.
	,, ,, 59	19·94	...	,,	,,	V.N.
	,, 19 2	17·91	89·2	1·6 S.	,,	P.
	,, ,, 3	17·88	89·2	,,	,,	V.N.
	,, ,, 7	17·84	89·2	1·6 N.	,,	P.
	,, ,, 8	17·85	89·2	,,	,,	V.N.
	,, ,, 10	19·86	...	1·4 N.	,,	P.
	,, ,, 11	19·84	...	,,	,,	V.N.
	,, ,, 14	23·60	...	1·2 N.	,,	P.
	,, ,, 15	23·59	...	,,	,,	V.N.
	,, ,, 20	4·34	...	1·2 N.	E.	P.
	,, ,, 21	4·35	...	,,	,,	V.N.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
VI.—8th August 1876.	1 19 24	8·08	...	1·4 N.	E.	P.
	„ „ 25	8·08	...	„	„	V.N.
	„ „ 30	10·12	...	1·6 N.	„	P.
	„ „ 31	10·14	...	„	„	V.N.
	„ „ 34	13·96	89·2	Away.	...	P.
	„ „ 35	13·96	89·2	„	...	V.N.
	8 16 38	14·00	86·3	Away.	...	P.
	„ „ 40	14·00	86·3	„	...	V.N.
	„ „ 45	13·53	...	3·0 S.	E.	P.
	„ „ 46	13·52	...	„	„	V.N.
	„ „ 48	13·17	...	2·5 S.	„	P.
	„ „ 49	13·17	...	„	„	V.N.
	„ „ 53	12·21	...	2·0 S.	„	P.
	„ „ 54	12·20	...	„	„	V.N.
	„ „ 56	9·52	...	1·5 S.	„	P.
	„ „ 57	9·53	...	„	„	V.N.
	„ „ 59	18·79	...	1·5 S.	W.	P.
	„ 17 0	18·80	...	„	„	V.N.
	„ „ 2	16·04	...	2·0 S.	„	P.
	„ „ 3	16·05	...	„	„	V.N.
	„ „ 5	15·11	...	2·5 S.	„	P.
	„ „ 6	15·11	...	„	„	V.N.
	„ „ 8	14·69	84·6	3·0 S.	„	P.
	„ „ 9	14·69	84·6	„	„	V.N.
	„ „ 11	14·73	84·6	3·0 N.	„	P.
	„ „ 12	14·73	84·6	„	„	V.N.
	„ „ 14	15·16	...	2·5 N.	„	P.
	„ „ 15	15·16	...	„	„	V.N.
	„ „ 17	16·11	...	2·0 N.	„	P.
	„ „ 18	16·12	...	„	„	V.N.
	„ „ 20	19·06	...	1·5 N.	„	P.
	„ „ 21	19·05	...	„	„	V.N.
	„ „ 23	9·34	...	1·5 N.	E.	P.
	„ „ 24	9·34	...	„	„	V.N.
	„ „ 26	12·26	...	2·0 N.	„	P.
	„ „ 27	12·26	...	„	„	V.N.
	„ „ 30	13·20	...	2·5 N.	„	P.
	„ „ 31	13·21	...	„	„	V.N.
	„ „ 33	13·62	84·5	3·0 N.	„	P.
	„ „ 34	13·61	84·5	„	„	V.N.
	„ „ 37	14·16	...	Away.	...	P.
	„ „ 38	14·16	...	„	...	V.N.
VII.—3rd May 1877.	3 16 40	14·00	89·0	Away.	...	P.
	„ „ 41	14·00	89·0	„	...	T.
	„ „ 43	13·35	...	3·0 S.	E.	P.
	„ „ 44	13·35	...	„	„	T.
	„ „ 46	12·93	...	2·5 S.	„	P.
	„ „ 47	12·93	...	„	„	T.
	„ „ 49	11·99	...	2·0 S.	„	P.
	„ „ 50	11·99	...	„	„	T.
	„ „ 52	9·10	...	1·5 S.	„	P.
	„ „ 53	9·10	...	„	„	T.
	„ „ 55	18·67	...	1·5 S.	W.	P.
	„ „ 56	18·68	...	„	„	T.
	„ „ 58	15·81	...	2·0 S.	„	P.
	„ „ 59	15·80	...	„	„	T.
	„ 17 1	14·85	...	2·5 S.	„	P.
	„ „ 2	14·86	...	„	„	T.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
VIII.—10th November 1877.	3 17 4	14·46	89·0	3·0 S.	W.	P.
	„ „ 5	14·47	89·0	„	„	T.
	„ „ 6½	14·41	88·9	3·0 N.	„	P.
	„ „ 7	14·41	89·0	„	„	T.
	„ „ 8½	14·80	...	2·5 N.	„	P.
	„ „ 9	14·80	...	„	„	T.
	„ „ 10½	15·73	...	2·0 N.	„	P.
	„ „ 11	15·74	...	„	„	T.
	„ „ 13	18·42	...	1·5 N.	„	P.
	„ „ 13½	18·43	...	„	„	T.
	„ „ 15	9·27	...	1·5 N.	E.	P.
	„ „ 16	9·27	...	„	„	T.
	„ „ 18	11·97	...	2·0 N.	„	P.
	„ „ 19	11·96	...	„	„	T.
	„ „ 20½	12·86	...	2·5 N.	„	P.
	„ „ 21	12·87	...	„	„	T.
	„ „ 23	13·30	...	3·0 N.	„	P.
	„ „ 24	13·30	...	„	„	T.
	„ „ 26	13·96	88·8	Away.	...	P.
	„ „ 27	13·96	88·8	„	...	T.
	10 16 23	14·00	90·0	Away.	...	P.
	„ „ 23	14·00	90·0	„	...	V.N.
	„ „ 29	13·43	...	3·0 S.	E.	P.
	„ „ 30	13·44	...	„	„	V.N.
	„ „ 32	13·04	...	2·5 S.	„	P.
	„ „ 33	13·04	...	„	„	V.N.
	„ „ 35	12·92	...	2·4 S.	„	P.
	„ „ 35	12·93	...	„	„	V.N.
	„ „ 37	12·08	...	2·0 S.	„	P.
	„ „ 38	12·09	...	„	„	V.N.
	„ „ 40	11·34	...	1·8 S.	„	P.
	„ „ 41	11·35	...	„	„	V.N.
	„ „ 43	16·73	...	1·8 S.	W.	P.
	„ „ 44	16·73	...	„	„	V.N.
	„ „ 45	15·95	...	2·0 S.	„	P.
	„ „ 46	15·95	...	„	„	V.N.
	„ „ 48	15·17	...	2·4 S.	„	P.
	„ „ 48	15·17	...	„	„	V.N.
	„ „ 50	15·07	...	2·5 S.	„	P.
	„ „ 50	15·07	...	„	„	V.N.
	„ „ 52	14·66	89·6	3·0 S.	„	P.
	„ „ 53	14·65	89·7	„	„	V.N.
	„ „ 54	14·64	89·6	3·0 N.	„	P.
	„ „ 55	14·64	89·7	„	„	V.N.
	„ „ 56	15·05	...	2·5 N.	„	P.
	„ „ 57	15·05	...	„	„	V.N.
	„ „ 59	15·16	...	2·4 N.	„	P.
	„ 17 0	15·16	...	„	„	V.N.
	„ „ 2	15·95	...	2·0 N.	„	P.
	„ „ 3	15·96	...	„	„	V.N.
	„ „ 4	16·70	...	1·8 N.	„	P.
	„ „ 5	16·71	...	„	„	V.N.
	„ „ 7	11·45	...	1·8 N.	E.	P.
	„ „ 8	11·44	...	„	„	V.N.
	„ „ 10	12·18	...	2·0 N.	„	P.
	„ „ 11	12·17	...	„	„	V.N.
	„ „ 12	12·98	...	2·4 N.	„	P.
	„ „ 13	12·97	...	„	„	V.N.
	„ „ 15	13·12	...	2·5 N.	„	P.
	„ „ 16	13·12	...	„	„	V.N.
	„ „ 18	13·44	...	3·0 N.	„	P.
	„ „ 19	13·45	...	„	„	V.N.
	„ „ 21	14·01	88·9	Away.	...	P.
	„ „ 22	14·00	88·9	„	...	V.N.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
IX.—10th February 1879.	d. h. m.					
	10 8 43	13·71	79·8	Away.	...	P.
	" " 44	13·71	79·7	"	...	V.D.
	" " 49	13·21	...	3·0 S.	E.	P.
	" " 50	13·20	...	"	"	V.D.
	" " 53	14·33	...	3·0 S.	W.	P.
	" " 54	14·34	...	"	"	V.D.
	" " 56	13·74	...	Away.	...	P.
	" " 57	13·73	...	"	...	V.D.
	" " 59	14·28	...	3·0 N.	W.	P.
	" 9 0	14·28	...	"	"	V.D.
	" " 2	13·21	...	3·0 N.	E.	P.
	" " 2	13·20	...	"	"	V.D.
	" " 5	13·75	79·8	Away.	...	P.
	" " 6	13·74	79·8	"	...	V.D.
	" " 9	12·84	...	2·5 N.	E.	P.
	" " 10	12·84	...	"	"	V.D.
	" " 13	14·68	...	2·5 N.	W.	P.
	" " 13	14·68	...	"	"	V.D.
	" " 16	13·75	...	Away.	...	P.
	" " 17	13·75	...	"	...	V.D.
	" " 20	12·82	...	2·5 S.	W.	P.
	" " 21	12·83	...	"	"	V.D.
	" " 23	14·69	79·9	2·5 S.	E.	P.
	" " 24	14·70	80·0	"	"	V.D.
	" " 27	13·75	...	Away.	...	P.
	" " 28	13·74	...	"	...	V.D.
	" " 30	12·51	...	2·3 S.	E.	P.
	" " 31	12·51	...	"	"	V.D.
	" " 34	15·00	...	2·3 S.	W.	P.
	" " 34	15·01	...	"	"	V.D.
	" " 37	13·78	...	Away.	...	P.
	" " 38	13·78	...	"	...	V.D.
	" " 40	14·97	...	2·3 N.	W.	P.
	" " 41	14·98	...	"	"	V.D.
	" " 43	12·53	...	2·3 N.	E.	P.
	" " 44	12·53	...	"	"	V.D.
	" " 46	13·75	80·3	Away.	...	P.
	" " 47	13·75	80·4	"	...	V.D.
	" " 50	11·88	...	2·0 N.	E.	P.
	" " 51	11·87	...	"	"	V.D.
	" " 55	15·56	...	2·0 N.	W.	P.
	" " 56	15·57	...	"	"	V.D.
	" " 59	13·74	...	Away.	...	P.
	" 10 0	13·73	...	"	...	V.D.
	" " 3	15·66	...	2·0 S.	W.	P.
	" " 4	15·67	...	"	"	V.D.
	" " 6	11·79	...	2·0 S.	E.	P.
	" " 7	11·80	...	"	"	V.D.
	" " 9	13·74	80·9	Away.	...	P.
	" " 10	13·74	81·0	"	...	V.D.
	" " 13	10·99	...	1·8 S.	E.	P.
	" " 14	11·00	...	"	"	V.D.
	" " 16	16·43	...	1·8 S.	W.	P.
	" " 17	16·44	...	"	"	V.D.
	" " 19	13·71	...	Away.	...	P.
	" " 20	13·70	...	"	...	V.D.
	" " 22	16·30	...	1·8 N.	W.	P.
	" " 23	16·31	...	"	"	V.D.
	" " 25	11·13	...	1·8 N.	E.	P.
	" " 26	11·12	...	"	"	V.D.
	" " 29	13·67	81·2	Away.	...	P.
	" " 30	13·68	81·3	"	...	V.D.
	12 16 11	13·99	79·6	Away.	...	P.
	" " 12	13·99	79·6	"	...	V.D.
	" " 15	13·39	...	3·0 S.	E.	P.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
X.—12th January 1880.	d. h. m.					
	12 16 16	13·40	...	3·0 S.	E.	V.D.
	" " 19	14·57	...	3·0 S.	W.	P.
	" " 19	14·58	...	"	"	V.D.
	" " 22	14·00	...	Away.	...	P.
	" " 22	14·00	...	"	...	V.D.
	" " 25	14·65	...	3·0 N.	W.	P.
	" " 26	14·64	...	"	"	V.D.
	" " 29	13·42	...	3·0 N.	E.	P.
	" " 30	13·43	...	"	"	V.D.
	" " 33	14·02	79·3	Away.	...	P.
	" " 34	14·01	79·3	"	...	V.D.
	" " 37	13·07	...	2·5 N.	E.	P.
	" " 38	13·07	...	"	"	V.D.
	" " 41	15·05	...	2·5 N.	W.	P.
	" " 42	15·04	...	"	"	V.D.
	" " 45	14·02	...	Away.	...	P.
	" " 46	14·03	...	"	...	V.D.
	" " 49	15·09	...	2·5 S.	W.	P.
	" " 49	15·09	...	"	"	V.D.
	" " 52	13·11	...	2·5 S.	E.	P.
	" " 52	13·10	...	"	"	V.D.
	" " 55	14·04	79·0	Away.	...	P.
	" " 56	14·04	79·0	"	...	V.D.
	" " 59	12·81	...	2·3 S.	E.	P.
	" 17 0	12·80	...	"	"	V.D.
	" " 3	15·34	...	2·3 S.	W.	P.
	" " 4	15·33	...	"	"	V.D.
	" " 7	14·04	...	Away.	...	P.
	" " 7	14·04	...	"	...	V.D.
	" " 10	15·35	...	2·3 N.	W.	P.
	" " 10	15·34	...	"	"	V.D.
	" " 13	12·84	...	2·3 N.	E.	P.
	" " 14	12·85	...	"	"	V.D.
	" " 18	14·06	78·8	Away.	...	P.
	" " 19	14·05	78·8	"	...	V.D.
	" " 22	12·14	...	2·0 N.	E.	P.
	" " 23	12·13	...	"	"	V.D.
	" " 25	16·00	...	2·0 N.	W.	P.
	" " 25	16·01	...	"	"	V.D.
	" " 27	14·06	...	Away.	...	P.
	" " 27	14·05	...	"	...	V.D.
	" " 30	16·10	...	2·0 S.	W.	P.
	" " 30	16·08	...	"	"	V.D.
	" " 33	12·10	...	2·0 S.	E.	P.
	" " 33	12·10	...	"	"	V.D.
	" " 36	14·07	77·9	Away.	...	P.
	" " 36	14·06	77·9	"	...	V.D.
	" " 40	11·30	...	1·8 S.	E.	P.
	" " 41	11·31	...	"	"	V.D.
	" " 44	16·60	...	1·8 S.	W.	P.
	" " 45	16·62	...	"	"	V.D.
	" " 47	14·06	...	Away.	...	P.
	" " 47	14·05	...	"	...	V.D.
	" " 50	16·74	...	1·8 N.	W.	P.
	" " 50	16·75	...	"	"	V.D.
	" " 54	11·46	...	1·8 N.	E.	P.
	" " 55	11·45	...	"	"	V.D.
	" " 59	14·05	...	Away.	...	P.
	" 18 0	14·04	...	"	...	V.D.
	16 19 3	14·01	90·0	Away.	...	P.
	" " 4	14·01	90·0	"	...	V.D.
	" " 6	13·45	...	3·0 S.	E.	P.
	" " 7	13·45	...	"	"	V.D.
	" " 9	14·55	...	3·0 S.	W.	P.
	" " 10	14·54	...	"	"	V.D.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E l. Distance in feet.	Magnet E l. North end.	Observer.
	d. h. m.					
XI.—16th April 1880.	16 19 12	14·02	...	Away.	...	P.
	" " 13	14·02	...	"	...	V.D.
	" " 15	14·55	...	3·0 N.	W.	P.
	" " 16	14·55	...	"	"	V.D.
	" " 19	13·46	...	3·0 N.	E.	P.
	" " 20	13·45	...	"	"	V.D.
	" " 22	14·02	89·8	Away.	...	P.
	" " 23	14·01	89·9	"	...	V.D.
	" " 25	13·66	...	2·5 N.	E.	P.
	" " 26	13·66	...	"	"	V.D.
	" " 28	14·94	...	2·5 N.	W.	P.
	" " 29	14·94	...	"	"	V.D.
	" " 31	14·01	...	Away.	...	P.
	" " 32	14·01	...	"	...	V.D.
	" " 34	14·95	...	2·5 S.	W.	P.
	" " 35	14·95	...	"	"	V.D.
	" " 37	13·04	...	2·5 S.	E.	P.
	" " 38	13·05	...	"	"	V.D.
	" " 40	14·00	89·7	Away.	...	P.
	" " 41	14·00	89·7	"	...	V.D.
	" " 43	12·76	...	2·3 S.	E.	P.
	" " 44	12·76	...	"	"	V.D.
	" " 46	15·24	...	2·3 S.	W.	P.
	" " 47	15·25	...	"	"	V.D.
	" " 49	14·01	...	Away.	...	P.
	" " 50	14·01	...	"	...	V.D.
	" " 52	15·24	...	2·3 N.	W.	P.
	" " 53	15·24	...	"	"	V.D.
	" " 55	12·77	...	2·3 N.	E.	P.
	" " 56	12·77	...	"	"	V.D.
	" " 58	14·01	89·4	Away.	...	P.
	" " 59	14·01	89·4	"	...	V.D.
	" 20 1	12·16	...	2·0 N.	E.	P.
	" " 2	12·16	...	"	"	V.D.
	" " 4	15·91	...	2·0 N.	W.	P.
	" " 5	15·91	...	"	"	V.D.
	" " 7	14·01	...	Away.	...	P.
	" " 8	14·00	...	"	...	V.D.
	" " 10	15·89	...	2·0 S.	W.	P.
	" " 11	15·89	...	"	"	V.D.
	" " 13	12·15	...	2·0 S.	E.	P.
	" " 14	12·15	...	"	"	V.D.
	" " 16	14·03	89·3	Away.	...	P.
	" " 17	14·02	...	"	...	V.D.
	" " 19	11·42	...	1·8 S.	E.	P.
	" " 20	11·42	...	"	"	V.D.
	" " 22	16·63	...	1·8 S.	W.	P.
	" " 23	16·63	...	"	"	V.D.
	" " 25	14·02	...	Away.	...	P.
	" " 26	14·02	...	"	...	V.D.
	" " 28	16·64	...	1·8 N.	W.	P.
	" " 29	16·65	...	"	"	V.D.
	" " 31	11·42	...	1·8 N.	E.	P.
	" " 32	11·42	...	"	"	V.D.
	" " 35	14·00	89·2	Away.	...	P.
	" " 36	14·00	...	"	...	V.D.
	11 8 30	13·87	79·6	Away.	...	P.
	" " 33	13·31	...	3·0 S.	E.	P.
	" " 36	14·45	...	3·0 S.	W.	P.
	" " 39	13·89	...	Away.	...	P.
	" " 42	14·43	...	3·0 N.	W.	P.
	" " 45	13·33	...	3·0 N.	E.	P.
	" " 48	13·90	79·8	Away.	...	P.
	" " 51	12·98	...	2·5 N.	E.	P.
	" " 54	14·81	...	2·5 N.	W.	P.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E l. Distance in feet.	Magnet E l. North end.	Observer.
	d. h. m.					
XII.—11th January 1881.	11 8 57	13·91	...	Away.	...	P.
	" 9 0	14·82	...	2·5 S.	W.	P.
	" " 3	12·97	...	2·5 S.	E.	P.
	" " 6	13·90	79·9	Away.	...	P.
	" " 9	12·61	...	2·3 S.	E.	P.
	" " 12	15·13	...	2·3 S.	W.	P.
	" " 15	13·88	...	Away.	...	P.
	" " 18	15·09	...	2·3 N.	W.	P.
	" " 21	12·66	...	2·3 N.	E.	P.
	" " 26	13·86	80·2	Away.	...	P.
	" " 30	12·03	...	2·0 N.	E.	P.
	" " 33	15·83	...	2·0 N.	W.	P.
	" " 37	13·85	...	Away.	...	P.
	" " 41	15·85	...	2·0 S.	W.	P.
	" " 44	11·99	...	2·0 S.	E.	P.
	" " 49	13·82	80·4	Away.	...	P.
	" " 52	11·14	...	1·8 S.	E.	P.
	" " 55	16·48	...	1·8 S.	W.	P.
	" " 58	13·80	...	Away.	...	P.
	" 10 3	16·39	...	1·8 N.	W.	P.
	" " 8	11·22	...	1·8 N.	E.	P.
	" " 13	13·81	80·6	Away.	...	P.
XIII.—9th March 1881.	8 18 40	14·02	82·9	Away.	...	P.
	" " 43	13·50	...	3·0 S.	E.	P.
	" " 47	14·55	...	3·0 S.	W.	P.
	" " 50	14·03	...	Away.	...	P.
	" " 53	14·55	...	3·0 N.	W.	P.
	" " 56	13·49	...	3·0 N.	E.	P.
	" 19 1	14·03	82·8	Away.	...	P.
	" " 4	13·10	...	2·5 N.	E.	P.
	" " 7	14·97	...	2·5 N.	W.	P.
	" " 9	14·02	...	Away.	...	P.
	" " 12	14·98	...	2·5 S.	W.	P.
	" " 15	13·09	...	2·5 S.	E.	P.
	" " 20	14·03	82·8	Away.	...	P.
	" " 23	12·79	...	2·3 S.	E.	P.
	" " 26	15·26	...	2·3 S.	W.	P.
	" " 29	14·02	...	Away.	...	P.
	" " 32	15·26	...	2·3 N.	W.	P.
	" " 35	12·83	...	2·3 N.	E.	P.
	" " 40	14·02	82·7	Away.	...	P.
	" " 43	12·21	...	2·0 N.	E.	P.
	" " 45	15·90	...	2·0 N.	W.	P.
	" " 48	14·03	...	Away.	...	P.
	" " 51	15·91	...	2·0 S.	W.	P.
	" " 54	12·18	...	2·0 S.	E.	P.
	" " 59	14·04	82·6	Away.	...	P.
	" 20 2	11·46	...	1·8 S.	E.	P.
	" " 5	16·65	...	1·8 S.	W.	P.
	" " 9	14·04	...	Away.	...	P.
	" " 12	16·66	...	1·8 N.	W.	P.
	" " 16	11·49	...	1·8 N.	E.	P.
	" " 20	14·03	82·6	Away.	...	P.
	13 19 20	13·98	91·9	Away.	...	P.
	" " 23	13·46	...	3·0 S.	E.	P.
	" " 26	14·51	...	3·0 S.	W.	P.
	" " 29	13·99	...	Away.	...	P.
	" " 32	14·53	...	3·0 N.	W.	P.
	" " 35	13·45	...	3·0 N.	E.	P.
	" " 38	13·98	91·9	Away.	...	P.
	" " 41	13·06	...	2·5 N.	E.	P.
	" " 44	14·92	...	2·5 N.	W.	P.

Number and date of experiment.	Local Time.	Scale-Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
XIV.—13th May 1881.	13 19 47	14·00	...	Away.	...	P.
	" " 50	14·94	...	2·5 S.	W.	P.
	" " 53	13·07	...	2·5 S.	E.	P.
	" " 56	13·99	91·8	Away.	...	P.
	" " 59	12·78	...	2·3 S.	E.	P.
	" 20 2	15·23	...	2·3 S.	W.	P.
	" " 5	14·01	...	Away.	...	P.
	" " 8	15·21	...	2·3 N.	W.	P.
	" " 11	12·80	...	2·3 N.	E.	P.
	" " 14	14·00	91·7	Away.	...	P.
	" " 17	12·15	...	2·0 N.	E.	P.
	" " 20	15·84	...	2·0 N.	W.	P.
	" " 23	13·99	...	Away.	...	P.
	" " 26	15·88	...	2·0 S.	W.	P.
	" " 29	12·14	...	2·0 S.	E.	P.
	" " 32	14·00	91·7	Away.	...	P.
	" " 35	11·39	...	1·8 S.	E.	P.
	" " 38	16·64	...	1·8 S.	W.	P.
	" " 41	14·00	...	Away.	...	P.
	" " 44	16·59	...	1·8 N.	W.	P.
	" " 47	11·46	...	1·8 N.	E.	P.
	" " 50	14·01	91·6	Away.	...	
XV.—6th June 1882.	6 20 14	14·00	86·5	Away.	...	P.
	" " 17	13·50	...	3·0 S.	E.	P.
	" " 21	14·52	...	3·0 S.	W.	P.
	" " 24	14·01	...	Away.	...	P.
	" " 28	14·53	...	3·0 N.	W.	P.
	" " 31	13·52	...	3·0 N.	E.	P.
	" " 34	14·02	86·5	Away.	...	P.
	" " 39	13·13	...	2·5 N.	E.	P.
	" " 42	14·96	...	2·5 N.	W.	P.
	" " 45	14·03	...	Away.	...	P.
	" " 48	15·01	...	2·5 S.	W.	P.
	" " 52	13·14	...	2·5 S.	E.	P.
	" " 57	14·05	86·5	Away.	...	P.
	" 21 2	12·81	...	2·3 S.	E.	P.
	" " 6	15·28	...	2·3 S.	W.	P.
	" " 9	14·03	...	Away.	...	P.
	" " 13	15·25	...	2·3 N.	W.	P.
	" " 17	12·84	...	2·3 N.	E.	P.
	" " 21	14·04	86·4	Away.	...	P.
	" " 24	12·24	...	2·0 N.	E.	P.
	" " 28	15·91	...	2·0 N.	W.	P.
	" " 32	14·02	...	Away.	...	P.
	" " 35	15·96	...	2·0 S.	W.	P.
	" " 39	12·19	...	2·0 S.	E.	P.
	" " 43	14·04	86·4	Away.	...	P.
	" " 47	11·42	...	1·8 S.	E.	P.
	" " 51	16·70	...	1·8 S.	W.	P.
	" " 55	14·05	...	Away.	...	P.
	" " 58	16·59	...	1·8 N.	W.	P.
	" 22 1	11·56	...	1·8 N.	E.	P.
	" " 4	14·05	86·3	Away.	...	P.
XVI.—6th July 1882.	6 21 39	14·00	82·6	Away.	...	P.
	" " 42	13·48	...	3·0 S.	E.	P.
	" " 45	14·53	...	3·0 S.	W.	P.
	" " 48	14·01	...	Away.	...	P.
	" " 51	14·53	...	3·0 N.	W.	P.
	" " 54	13·47	...	3·0 N.	E.	P.
	" " 57	14·02	82·6	Away.	...	P.
	" 22 0	13·10	...	2·5 N.	E.	P.
	" " 3	14·99	...	2·5 N.	W.	P.

Number and date of experiment.	Local Time.	Scale-Reading	Thermometer.	Magnet E 1. Distance, in feet.	Magnet E 1. North end.	Observer.
XVI.—*continued.*	d. h. m.					
	6 22 6	14·03	...	Away.	...	P.
	" " 9	14·98	...	2·5 S.	W.	P.
	" " 12	13·07	...	2·5 S.	E.	P.
	" " 15	14·04	82·5	Away.	...	P.
	" " 18	12·85	...	2·3 S.	E.	P.
	" " 21	15·26	...	2·3 S.	W.	P.
	" " 24	14·07	...	Away.	...	P.
	" " 27	15·27	...	2·3 N.	W.	P.
	" " 30	12·84	...	2·3 N.	E.	P.
	" " 33	14·05	82·5	Away.	...	P.
	" " 36	12·18	...	2·0 N.	E.	P.
	" " 39	15·94	...	2·0 N.	W.	P.
	" " 42	14·07	...	Away.	...	P.
	" " 45	15·93	...	2·0 S.	W.	P.
	" " 48	12·17	...	2·0 S.	E.	P.
	" " 51	14·06	82·5	Away.	...	P.
	" " 54	11·49	...	1·8 S.	E.	P.
	" " 56	16·63	...	1·8 S.	W.	P.
	" " 59	14·06	...	Away.	...	P.
	" 23 2	16·66	...	1·8 N.	W.	P.
	" " 5	11·48	...	1·8 N.	E.	P.
	" " 8	14·06	82·5	Away.	...	P.
	" " 11	9·99	...	1·558 N.	E.	P.
	" " 14	18·16	...	1·558 N.	W.	P.
	" " 17	18·12	...	1·558 S.	W.	P.
	" " 20	10·03	...	1·558 S.	E.	P.
	" " 23	9·28	...	1·477 S.	E.	P.
	" " 26	18·85	...	1·477 S.	W.	P.
	" " 29	18·91	...	1·477 N.	W.	P.
	" " 32	9·24	...	1·477 N.	E.	P.
	" " 35	8·56	...	1·416 N.	E.	P.
	" " 38	19·62	...	1·416 N.	W.	P.
	" " 41	19·56	...	1·416 S.	W.	P.
	" " 44	8·58	...	1·416 S.	E.	P.
	" " 47	7·27	...	1·323 S.	E.	P.
	" " 49	20·85	...	1·323 S.	W.	P.
	" " 51	20·92	...	1·323 N.	W.	P.
	" " 54	7·22	...	1·323 N.	E.	P.
	" " 57	5·96	...	1·256 N.	E.	P.
	" " 59	22·22	...	1·256 N.	W.	P.
	7 0 2	22·13	...	1·256 S.	W.	P.
	" " 5	6·02	...	1·256 S.	E.	P.
	" " 8	14·10	82·5	Away.	...	P.
	" " 12	5·05	...	1·209 S.	E.	P.
	" " 15	23·18	...	1·209 S.	W.	P.
	" " 18	23·31	...	1·209 N.	W.	P.
	" " 21	4·94	...	1·209 N.	E.	P.
	" " 24	3·92	...	1·169 N.	E.	P.
	" " 27	24·39	...	1·169 N.	W.	P.
	" " 30	24·42	...	1·169 S.	W.	P.
	" " 32	3·99	...	1·169 S.	E.	P.
	" " 34	2·94	...	1·136 S.	E.	P.
	" " 37	25·39	...	1·136 S.	W.	P.
	" " 40	25·49	...	1·136 N.	W.	P.
	" " 43	2·99	...	1·136 N.	E.	P.
	" " 46	2·15	...	1·112 N.	E.	P.
	" " 49	26·17	...	1·112 N.	W.	P.
	" " 52	26·02	...	1·112 S.	W.	P.
	" " 54	2·03	...	1·112 S.	E.	P.
	" " 57	1·37	...	1·088 S.	E.	P.
	" 1 0	26·78	...	1·088 S.	W.	P.
	" " 3	26·92	...	1·088 N.	W.	P.
	" " 6	1·48	...	1·088 N.	E.	P.
	" " 10	14·18	82·5	Away.	...	P.
	" " 13	0·39	...	1·067 N.	E.	P.
	" " 17	27·94	...	1·067 N.	W.	P.
	" " 20	27·86	...	1·067 S.	W.	P.
	" " 24	0·43	...	1·069 S.	E.	P.
	" " 28	14·16	82·5	Away.	...	P.

Special set of deflections of the Vertical Force Magnetograph Magnet. 8th July 1876.

Number and date of experiment.	Local Time. d. h. m. s.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	8 12 17	23·99	89·9	Away.	...	P.
	" " 18	23·99	89·9	"	...	V. D.
	" " 24	9·24	...	1·5 S.	E.	P.
	" " 25	9·25	...	"	"	V. D.
	" " 28	8·08	...	1·4 S.	E.	P.
	" " 29	8·67	...	"	"	V. D.
	" " 31	6·52	...	1·3 S.	E.	P.
	" " 32	6·52	...	"	"	V. D.
	" " 36	5·50	...	1·25 S.	E.	P.
	" " 37	5·49	...	"	"	V. D.
	" " 39	4·33	...	1·20 S.	E.	P.
	" " 40	4·33	...	"	"	V. D.
	" " 44	2·93	...	1·15 S.	E.	P.
	" " 45	2·93	...	"	"	V. D.
	" " 47	1·27	...	1·10 S.	E.	P.
	" " 47	1·27	...	"	"	V. D.
			Out of	field at 1·05	feet.	
	" " 57	26·44	...	1·10 S.	W.	P.
	" " 58	26·45	...	"	"	V. D.
	" 13 0	24·74	...	1·15 S.	W.	P.
	" " 1	24·76	...	"	"	V. D.
	" " 3	23·35	...	1·20 S.	W.	P.
	" " 4	23·36	...	"	"	V. D.
	" " 6	22·17	...	1·25 S.	W.	P.
	" " 7	22·19	...	"	"	V. D.
	" " 9	21·22	...	1·30 S.	W.	P.
	" " 10	21·22	...	"	"	V. D.
	" " 12	19·66	...	1·40 S.	W.	P.
	" " 13	19·67	...	"	"	V. D.
	" " 15	18·53	...	1·50 S.	W.	P.
	" " 16	18·55	...	"	"	V. D.

Special set of deflections of the Vertical Force Magnetograph Magnet. 8th July 1876—*continued.*

Number and date of experiment.	Local Time. d. h. m. s.	Scale Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	8 13 18	18·56	88·9	1·5 N.	W.	P.
	" " 19	18·56	88·9	"	"	V. D.
	" " 21	19·70	...	1·4 N.	W.	P.
	" " 22	19·72	...	"	"	V. D.
	" " 24	21·28	...	1·3 N.	W.	P.
	" " 25	21·26	...	"	"	V. D.
	" " 27	22·24	...	1·25 N.	W.	P.
	" " 28	22·25	...	"	"	V. D.
	" " 30	23·42	...	1·20 N.	W.	P.
	" " 31	23·42	...	"	"	V. D.
	" " 33	24·85	...	1·15 N.	"	P.
	" " 34	24·85	...	"	"	V. D.
	" " 36	26·51	...	1·10 N.	"	P.
	" " 37	26·51	...	"	"	V. D.
			Out of	field at 1·05	at E. and W.	
	" " 48	0·94	...	1·10 N.	E.	P.
	" " 49	0·94	...	"	"	V. D.
	" " 51	2·65	...	1·15 N.	E.	P.
	" " 52	2·65	...	"	"	V. D.
	" " 54	4·04	...	1·20 N.	E.	P.
	" " 55	4·04	...	"	"	V. D.
	" " 57	5·25	...	1·25 N.	E.	P.
	" " 58	5·25	...	"	"	V. D.
	" 14 0	6·26	...	1·30 N.	E.	P.
	" " 1	6·26	...	"	"	V. D.
	" " 3	7·85	...	1·40 N.	E.	P.
	" " 4	7·85	...	"	"	V. D.
	" " 6	9·02	...	1·50 N.	E.	P.
	" " 7	9·03	...	"	"	V. D.
	" " 10	13·79	88·6	Away.	...	P.
	" " 11	13·79	88·6	"	...	V. D.

TABLE 3.—*Experimental deflections of the Magnet* N 3, *suspended in the Electrometer Tower, by the deflector Magnet* E 1.

CALCULATION, FROM THE DATA IN TABLE 2, OF THE DOUBLE DEFLECTIONS.

Number of experiment.	Distance.	Means. Higher reading.	Means. Lower reading.	Difference or double deflection.	Double deflection. Corrected for crack in the scale.	Torsion coefficient.	Value of one division of scale.*	Deflection of Magnet N 23c by Magnet E 1 at 1 foot distance.
II.	3·0	14·72	13·36	1·36	...	1·00103	14′·36	...
12th	2·0	16·37	11·72	4·65	...	..	...	...
April	1·5	19·77	8·31	11·46	...	...	...	...
1872.	1·2	25·67	2·42	23·25	...	...	...	...
III.	3·0	14·49	13·41	1·08	...	1·00551	14′·37	...
10th	2·0	15·90	12·02	3·88	...	...	...	...
Sept.	1·5	18·82	9·13	9·69	...	...	...	...
1873.	1·2	23·87	3·95	19·92	...	...	...	...
IV.	2·4	15·03	12·78	2·25	...	1·00549	14′·36	...
13th	2·0	15·92	11·94	3·98	...	...	...	...
Sept.	1·8	16·68	11·17	5·51	...	...	...	...
1873.								
V.	2·4	15·14	12·89	2·25	...	1·00387	14′·29	...
	2·0	15·94	12·09	3·85	...	...	...	...
1st	1·8	16·68	11·33	5·35	...	...	...	...
July	1·6	17·87	10·08	7·79	...	...	...	...
1876.	1·4	19·90	8·01	11·89	...	...	...	...
	1·2	23·66	4·22	19·44	...	...	...	...
VI.	3·0	14·71	13·57	1·14	—	1·00541	14′·29	...
8th	2·5	15·13	13·19	1·94	...	...	...	...
August	2·0	16·08	12·23	3·85	...	...	...	...
1876.	1·5	18·92	9·43	9·49	...	...	...	...
VII.	3·0	14·43	13·32	1·11	...	1·0063	14′·32	...
3rd	2·5	14·83	12·90	1·93	...	...	...	...
May	2·0	15·77	11·98	3·79	...	...	...	...
1877.	1·5	18·55	9·18	9·37	...	...	...	...
VIII.	3·0	14·65	13·44	1·21	...	1·00530	14′·30	...
	2·5	15·06	13·08	1·98	...	...	...	...
10th	2·4	15·16	12·95	2·21	†	...	...	...
Nov.	2·0	15·95	12·13	3·82	3·85	...	...	...
1877.	1·8	16·72	11·39	5·33	5·36	...	...	...
IX.	3·0	14·31	13·20	1·11	...	1·00199	14′·30	...
	2·5	14·69	12·83	1·86	...	...	...	...
10th	2·3	14·99	12·52	2·47	...	...	...	...
Feby.	2·0	15·61	11·83	3·78	3·81	...	...	...
1879.	1·8	16·37	11·06	5·31	5·34	...	...	...
X.	3·0	14·61	13·41	1·20	...	1·00159	14′·30	—
	2·5	15·07	13·09	1·98	...	...	...	...
12th	2·3	15·34	12·82	2·52	...	...	...	...
January	2·0	16·05	12·12	3·93	3·96	...	...	...
1880.	1·8	16·68	11·38	5·30	5·33	...	...	...
XI.	3·0	14·55	13·45	1·10	...	1·00154	14′·30	...
	2·5	14·94	13·05	1·89	...	...	...	...
16th	2·3	15·24	12·76	2·48	...	...	...	...
April	2·0	15·90	12·15	3·75	3·78	..	...	...
1880.	1·8	16·64	11·42	5·22	5·25	...	...	...
XII.	3·0	14·44	13·32	1·12	...	1·00162	14′·30	‡6° 55′
	2·5	14·81	12·97	1·84	...	...	...	...
11th	2·3	15·11	12·63	2·48	...	...	...	...
January	2·0	15·84	12·01	3·83	3·86	...	...	...
1881.	1·8	16·43	11·18	5·25	5·28	...	...	...
XIII.	3·0	14·55	13·49	1·06	...	1·00207	14′·30	6° 55′
	2·5	14·97	13·09	1·88	...	...	...	...
5th	2·3	15·26	12·81	2·45	...	...	...	...
March	2·0	15·90	12·19	3·71	3·74	...	...	...
1881.	1·8	16·65	11·47	5·18	5·21	...	...	...
XIV.	3·0	14·52	13·45	1·07	...	1·00191	14′·30	6° 54′
	2·5	14·93	13·06	1·87	...	...	...	...
13th	2·3	15·22	12·79	2·43	...	...	...	...
May	2·0	15·86	12·14	3·72	3·75	...	...	...
1881.	1·8	16·61	11·42	5·19	5·22	...	...	...
XV.	3·0	14·52	13·51	1·01	...	1·00117	14′·30	6° 52′
	2·5	14·98	13·13	1·85	...	...	...	...
6th	2·3	15·26	12·82	2·44	...	...	...	...
June	2·0	15·93	12·21	3·72	3·75	...	...	...
1882.	1·8	16·64	11·49	5·15	5·18	...	...	...
XVI.	3·0	14·53	13·47	1·06	...	1·00107	14′·30	6° 52′
	2·5	14·98	13·08	1·90	...	...	...	...
	2·3	15·26	12·84	2·42	...	...	...	...
	2·0	15·93	12·17	3·76	3·79	...	...	...
	1·8	16·64	11·48	5·16	5·19	...	...	...
	1·558	18·14	10·01	8·13	8·16	...	...	...
	1·477	18·88	9·26	9·62	9·65	...	...	...
6th July 1882.	1·416	19·58	8·57	11·01	11·04	...	...	...
	1·323	20·88	7·24	13·64	13·67	...	...	...
	1·256	22·17	5·99	16·18	16·21	...	...	...
	1·209	23·24	4·99	18·25	18·28	...	...	...
	1·169	24·40	3·95	20·45	20·48	...	...	...
	1·136	25·44	2·96	22·48	22·51	...	...	...
	1·112	26·09	2·09	24·00	24·03	...	...	...
	1·088	26·85	1·42	25·43	25·46	...	...	...
	1·067	27·90	0·41	27·49	27·52	...	...	...
Special set of deflections. 8th July 1876.	1·5	18·55	9·13	9·42	...	1·0158	14′·31	...
	1·4	19·69	7·96	11·73	...	...	...	...
	1·3	21·24	6·39	14·85	...	...	...	...
	1·25	22·21	5·37	16·84	...	...	...	...
	1·2	23·39	4·18	19·21	...	...	...	...
	1·15	24·80	2·79	22·01	...	...	...	...
	1·1	26·48	1·10	25·38	...	...	...	...

* This depends on the distance of the mirror attached to the suspended magnet from the scale, a distance which is not, in all the sets of experiments, exactly the same.

† The ivory scale, which before had been unbroken, was found cracked between the divisions 12·5 and 13 on the 10th November 1877; the crack gapes to the extent of ·03 division.

‡ These observations are taken to remove any doubt about the practical constancy of strength of the deflector Magnet E 1. As the horizontal force changes but slightly the magnetic movement of E 1 is nearly proportional to the sines of these angles or roughly to the angles themselves. Magnet N 23c is the suspended magnet, in the deflection experiment, of the Unifilar Magnetometer by Elliott Brothers, used for the regular determination of absolute horizontal force.

TABLE 4.—*Experimental deflections of the Vertical Force Magnetograph by the deflector Magnet E 1.*

Number and date of experiment.	Local Time by Magnetograph Clock.*	Vertical Force Magnetograph — Scale reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).†
	d. h. m.							
I. 8th—9th February 1872.	...	32·10	...	...	Away.	...	C.C.	.....
	8 15 16	49·53	...	...	1·7 N.	Up.	C.C.	+ ·060248
	,, ,, 22	45·27	...	...	1·8 N.	Up.	C.C.	+ ·050527
	,, ,, 30	42·60	...	...	1·9 N.	Up.	C.C.	+ ·042799
	,, ,, 33	40·77	...	...	2·0 N.	Up.	C.C.	+ ·036577
	,, ,, 34	39·44	...	...	2·1 N.	Up.	C.C.	+ ·031509
	,, ,, 37	38·45	...	...	2·2 N.	Up.	C.C.	+ ·027339
	,, ,, 40	37·62	...	...	2·3 N.	Up.	C.C.	+ ·023876
	,, ,, 42	36·99	...	...	2·4 N.	Up.	C.C.	+ ·020976
	,, ,, 44	36·45	...	...	2·5 N.	Up.	C.C.	+ ·018529
	,, ,, 46	36·01	...	...	2·6 N.	Up.	C.C.	+ ·016448
	,, ,, 48	35·64	...	...	2·7 N.	Up.	C.C.	+ ·014669
	,, ,, 51	35·32	...	...	2·8 N.	Up.	C.C.	+ ·013138
	,, ,, 53	35·04	...	...	2·9 N.	Up.	C.C.	+ ·011813
	,, ,, 56	34·80	...	...	3·0 N.	Up.	C.C.	+ ·010661
	,, 16 11	34·81	...	...	3·0 N.	Up.	C.C.	
	,, ,, 17	34·82	...	...	3·0 S.	Up.	C.C.	
	,, ,, 22	35·02	...	...	2·9 S.	Up.	C.C.	+ ·011813
	,, ,, 25	35·27	...	...	2·8 S.	Up.	C.C.	+ ·013138
	,, ,, 27	35·58	...	...	2·7 S.	Up.	C.C.	+ ·014669
	,, ,, 29	35·93	...	...	2·6 S.	Up.	C.C.	+ ·016448
	,, ,, 42	28·83	...	...	2·6 S.	Down.	C.C.	— ·016448
	,, ,, 43	29·21	...	...	2·7 S.	Down.	C.C.	— ·014669
	,, ,, 45	29·58	...	...	2·8 S.	Down.	C.C.	— ·013138
	,, ,, 47	29·86	...	...	2·9 S.	Down.	C.C.	— ·011813
	,, ,, 50	30·11	...	...	3·0 S.	Down.	C.C.	— ·010661
	9 14 34	29·46	..	...	3·0 N.	Down.	C.C.	
	,, ,, 37	29·22	...	...	2·9 N.	Down.	C.C.	— ·011813
	,, ,, 39	28·92	...	...	2·8 N.	Down.	C.C.	— ·013138
	,, ,, 41	28·57	...	...	2·7 N.	Down.	C.C.	— ·014669
	,, ,, 43	28·11	...	...	2·6 N.	Down.	C.C.	— ·016448
	,, ,, 44	27·60	...	...	2·5 N.	Down.	C.C.	— ·018529
	,, ,, 46	26·88	...	...	2·4 N.	Down.	C.C.	— ·020976
	,, ,, 48	26·03	...	...	2·3 N.	Down.	C.C.	— ·023876
	,, ,, 50	24·88	...	...	2·2 N.	Down.	C.C.	— ·027339
	,, ,, 52	23·35	...	...	2·1 N.	Down.	C.C.	— ·031509
	,, ,, 54	21·11	...	...	2·0 N.	Down.	C.C.	— ·036577
	,, ,, 58	16·98	...	...	1·9 N.	Down.	C.C.	— ·042799
	,, 15 1	7·03	...	...	1·8 N.	Down.	C.C.	— ·050527
	,, ,, 29	31·69	89·4	...	Away.	...	C.C.	.....
II. 11th April 1872.	11 14 37	39·85	90·3	1·63	Away.	...	C.C. and V.N.	.....
	,, ,, 50	38·46	...	...	3·0 N.	Down.		— ·010659
	,, ,, 53	38·18	90·3	...	2·8 N.	Down.		— ·013116
	,, ,, 55	37·75	...	...	2·6 N.	Down.		— ·016390
	,, ,, 56	37·21	...	...	2·4 N.	Down.		— ·020853
	,, ,, 58	36·40	...	...	2·2 N.	Down.		— ·027097
	,, 15 0	35·26	...	...	2·0 N.	Down.		— ·036109
	,, ,, 3	33·49	...	...	1·8 N.	Down.		— ·049610
	,, ,, 6	30·69	...	...	1·6 N.	Down.		— ·070792
	,, ,, 10	28·37	...	...	1·5 N.	Down.		— ·086040
	,, ,, 16	26·84	...	...	1·45 N.	Down.		— ·095331
	,, ,, 12	24·99	...	...	1·40 N.	Down.		— ·106013
	,, ,, 20	18·62	...	...	1·30 N.	Down.		— ·132700
	,, ,, 25	13·26	...	...	1·25 N.	Down.		— ·149464
	,, ,, 30	5·03	...	...	1·20 N.	Down.		— ·169185
	,, ,, 39	40·64	...	...	3·0 N.	Up.		+ ·010659
	,, ,, 42	41·00	...	...	2·8 N.	Up.		+ ·013116
	,, ,, 44	41·52	...	...	2·6 N.	Up.		+ ·016390
	,, ,, 46	42·26	...	...	2·4 N.	Up.		+ ·020853
	,, ,, 49	43·25	...	...	2·2 N.	Up.		+ ·027097
	,, ,, 53	44·99	...	...	2·0 N.	Up.		+ ·036109
	,, ,, 56	46·45	...	...	1·9 N.	Up.		+ ·042146
	,, 16 0	48·23	90·0	...	1·8 N.	Up.		+ ·049610
	,, ,, 12	49·22	90·0	...	1·8 S.	Up.		
	,, ,, 16	47·48	...	...	1·9 S.	Up.		+ ·042146
	,, ,, 20	46·17	...	...	2·0 S.	Up.		+ ·036109
	,, ,, 23	44·41	...	...	2·2 S.	Up.		+ ·027097
	,, ,, 25	43·31	...	...	2·4 S.	Up.		+ ·020853
	,, ,, 28	42·51	...	...	2·6 S.	Up.		+ ·016390
	,, ,, 29	41·98	...	...	2·8 S.	Up.		+ ·013116
	,, ,, 30	41·62	...	...	3·0 S.	Up.		+ ·010659
	,, ,, 34	38·60	...	...	3·0 S.	Down.		— ·010659
	,, ,, 36	38·28	...	...	2·8 S.	Down.		— ·013116
	,, ,, 38	37·81	...	...	2·6 S.	Down.		— ·016390
	,, ,, 39	37·20	...	...	2·4 S.	Down.		— ·020853
	,, ,, 41	36·35	...	...	2·2 S.	Down.		— ·027097

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
	d. h. m.							
II. *continued.* 12th September 1873.	11 16 44	35·08	...	...	2·0 S.	Down.	C. C. and V. N.	— ·036109
	,, ,, 47	33·24	...	..	1·8 S.	Down.		— ·049610
	,, ,, 52	30·00	...	...	1·6 S.	Down.		— ·070792
	,, ,, 54	27·55	...	...	1·5 S.	Down.		— ·086040
	,, ,, 58	23·81	...	...	1·4 S.	Down.		— ·106013
	,, 17 2	17·03	...	...	1·3 S.	Down.		— ·132700
	,, ,, 12	10·41	...	...	1·25 S.	Down.		— ·149464
	,, ,, 7	2·15	...	...	1·20 S.	Down.		— ·169185
	,, ,, 18	39·94	90·2	1·63	Away.	...		.....
III.	12 14 29	33·03	87·9	2·43	Away.	...	P.	.....
	,, ,, 52	32·01	88·1	...	3·0 N.	Down.	P.	— ·009017
	,, ,, 53	32·02	88·5	...	,,	,,	V.N.	
	,, 15 4	31·82	...	...	2·8 N.	Down.	P.	— ·011096
	,, ,, 5	31·80	...	...	,,	,,	V.N.	
	,, ,, 12	31·43	...	...	2·6 N.	Down.	P.	— ·013866
	,, ,, 13	31·42	..	...	,,	,,	V.N.	
	,, ,, 22	30·99	...	...	2·4 N.	Down.	P.	— ·017641
	,, ,, 23	30·94	...	...	,,	,,	V.N.	
	,, ,, 24	30·32	...	...	2·2 N.	Down.	P.	— ·022924
	,, ,, 30	30·32	...	...	,,	,,	V.N.	
	,, ,, 37	29·32	...	...	2·0 N.	Down.	P.	— ·030547
	,, ,, 38	29·32	...	...	,,	,,	V.N.	
	,, ,, 45	27·71	...	...	1·8 N.	Down.	P.	— ·041969
	,, ,, 47	27·72	...	...	,,	,,	V.N.	
	,, ,, 54	24·88	...	...	1·6 N.	Down.	P.	— ·059888
	,, ,, 55	24·87	...	...	,,	,,	V.N.	
	,, 16 15	22·16	...	...	1·5 N.	Down.	V.N.	— ·072788
	,, ,, 16	22·18	...	...	,,	,,	G.	
	,, ,, 17	32·65	88·1	...	Away.	...	T.	.....
	,, ,, 31	20·42	...	...	1·45 N.	Down.	V.N.	— ·080648
	,, ,, 32	20·41	...	...	,,	,,	G.	
	,, ,, 53	17·82	...	...	1·4 N.	Down.	V.N.	— ·089685
	,, ,, 54	17·81	...	...	,,	,,	G.	
	,, 17 2	9·82	...	...	1·3 N.	Down.	V.N.	— ·112261
	,, ,, 2	9·80	...	...	,,	,,	G.	
	,, ,, 12	2·90	90·0	...	1·25 N.	Down.	V.N.	— ·126443
	,, ,, 12	2·89	90·1	...	,,	,,	G.	
		Scale	out of	field.	1·20 N.	Down.	V.N.	.....
			Do.		,,	,,	G.	.....
	,, ,, 35	33·52	90·0	...	3·0 N.	Up.	V.N.	+ ·009017
	,, ,, 35	33·54	90·1	...	,,	,,	G.	
	,, ,, 45	33·80	...	...	2·8 N.	Up.	V.N.	+ ·011096
	,, ,, 46	33·81	...	...	,,	,,	G.	
	,, ,, 50	34·23	...	..	2·6 N.	Up.	V.N.	+ ·013866
	,, ,, 50	34·26	...	...	,,	,,	G.	
	,, ,, 58	34·68	...	...	2·4 N.	Up.	V.N.	+ ·017641
	,, ,, 58	34·69	...	...	,,	,,	G.	
	,, 18 3	35·25	...	...	2·2 N.	Up.	V.N.	+ ·022924
	,, ,, 4	35·25	...	...	,,	,,	G.	
	,, ,, 8	36·08	...	...	2·0 N.	Up.	V.N.	+ ·030547
	,, ,, 9	36·11	...	...	,,	,,	G.	
	,, ,, 13	36·80	...	...	1·9 N.	Up.	V.N.	+ ·035654
	,, ,, 15	36·82	...	...	,,	,,	G.	
	,, ,, 17	37·58	...	...	1·8 N.	Up.	V.N.	+ ·041969
	,, ,, 19	37·60	...	...	,,	,,	G.	
	,, ,, 23	38·60	...	...	1·7 N.	Up.	V.N.	+ ·049869
	,, ,, 24	38·60	...	...	,,	,,	G.	
	,, ,, 27	40·00	...	...	1·6 N.	Up.	V.N.	+ ·059888
	,, ,, 27	40·00	...	...	,,	,,	G.	
	,, ,, 30	42·13	...	...	1·5 N.	Up.	V.N.	+ ·0 72788
	,, ,, 31	42·13	...	...	,,	,,	G.	
	,, ,, 33	43·49	...	...	1·45 N.	Up.	V.N.	+ ·080648
	,, ,, 33	43·49	...	...	,,	,,	G.	
	,, ,, 37	45·21	89·6	...	1·40 N.	Up.	V.N.	+ ·089685
	,, ,, 38	45·23	89·6	...	,,	,,	G.	
		Scale	out of	field.	1·30 N.	Up.	P.	
			Do.		,,	,,	V.N.	
		Scale	out of	field.	1·30 S.	Up.	P.	
			Do.		,,	,,	V.N.	
	,, 19 13	46·55	89·7	...	1·40 S.	Up.	P.	
	,, ,, 13	46·55	89·6	...	,,	,,	V.N.	+ ·089685
	,, ,, 16	44·53	...	...	1·45 S.	Up.	P.	
	,, ,, 17	44·52	...	...	,,	,,	V.N.	+ ·080648
	,, ,, 19	43·00	...	...	1·50 S.	Up.	P.	
	,, ,, 20	42·99	...	...	,,	,,	V.N.	+ ·072788

* Reckoned from midnight.

† Calculated by equation (8) with the constants of Table 10 and by aid of Table 11.

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
III.	d. h. m.							
12th September 1873—*continued.*	12 19 23	40·71	...	...	1·60 S.	Up.	P.	
	,, ,, 23	40·72	...	...	,,	,,	V.N.	+·059888
	,, ,, 28	39·19	...	...	1·70 S.	Up.	P.	
	,, ,, 28	39·18	...	...	,,	,,	V.N.	+·049869
	,, ,, 33	38·10	...	...	1·80 S.	Up.	P.	
	,, ,, 34	38·10	...	...	,,	,,	V.N.	+·041969
	,, ,, 37	37·20	...	...	1·90 S.	Up.	P.	
	,, ,, 38	37·21	...	...	,,	,,	V.N.	+·035654
	,, ,, 42	36·49	...	...	2·00 S.	Up.	V.	
	,, ,, 43	36·50	...	...	,,	,,	K.S.	+·030547
	,, ,, 46	35·37	...	...	2·20 S.	Up.	V.	
	,, ,, 47	35·60	...	—	,,	,,	K.S.	+·022924
	,, ,, 50	35·00	...	...	2·40 S.	Up.	V.	
	,, ,, 51	35·00	...	—	,,	,,	K.S.	+·017641
	,, ,, 53	34·58	...	...	2·60 S.	Up.	V.	
	,, ,, 54	34·59	...	—	,,	,,	K.S.	+·013866
	,, ,, 56	34·22	...	...	2·80 S.	Up.	V.	
	,, ,, 57	34·22	...	—	,,	,,	K.S.	+·011096
	,, 20 0	34·00	...	...	3·00 S.	Up.	V.	
	,, ,, 1	34·00	...	—	,,	,,	K.S.	+·009017
	,, ,, 2	31·95	...	...	3·00 S.	Down.	V.	
	,, ,, 3	31·95	...	—	,,	,,	K.S.	−·009017
	,, ,, 5	31·70	...	...	2·80 S.	Down.	V	
	,, ,, 6	31·70	...	—	,,	,,	K.S.	−·011096
	,, ,, 8	31·36	...	...	2·60 S.	Down.	V.	
	,, ,, 9	31·36	...	—	,,	,,	K.S.	−·013866
	,, ,, 11	30·90	...	...	2·40 S.	Down.	V.	
	,, ,, 12	30·90	...	—	,,	,,	K.S.	−·017641
	,, ,, 14	30·22	...	...	2·20 S.	Down.	V.	
	,, ,, 15	30·22	...	—	,,	,,	K.S.	−·022924
	,, ,, 17	29·20	...	...	2·00 S.	Down.	V.	
	,, ,, 18	29·20	...	—	,,	,,	K.S.	−·030547
	,, ,, 20	27·53	...	...	1·80 S.	Down.	V.	
	,, ,, 21	27·52	...	—	,,	,,	K.S.	−·041969
	,, ,, 25	24·32	...	...	1·60 S.	Down.	V.	
	,, ,, 26	24·32	...	—	,,	,,	K.S.	−·059888
	,, ,, 29	21·40	...	...	1·50 S.	Down.	V.	
	,, ,, 30	21·40	...	—	,,	,,	K.S.	−·072788
	,, ,, 34	16·18	...	...	1·40 S.	Down.	V.	
	,, ,, 34	16·16	...	—	,,	,,	K.S.	−·089685
	,, ,, 45	6·48	...	...	1·30 S.	Down.	V.	
	,, ,, 49	6·48	...	—	,,	,,	K.S.	−·112261
	,, ,, 52	0·20	...	...	1·26 S.	Down.	V.	
	,, ,, 56	0·20	89·5	...	,,	,,	C.C.	−·123423
	,, ,, 56	0·20	89·4	2·47	,,	,,	K.S.	
	...	Scale	out of	field.	1·25 S.	Down.	...	.....
		Do.			,,	,,	...	.....
	,, 21 3	32·40	89·4	...	Away.	...	K.S.	.....
	,, ,, 5	32·45	89·5	...	,,	...	C.C.	.....
IV.	13 13 40	32·90	87·9	2·56	Away.	...	P.	.....
	,, ,, 41	32·89	88·2	2·50	,,	...	V.N.	.....
	,, 14 17	32·80	87·9	2·44	,,	...	T.	.....
	,, ,, 22	30·80	...	...	2·4 N.	Down.	V.	
	,, ,, 23	30·81	...	...	,,	,,	V.N.	−·017641
	,, ,, 25	29·09	...	...	2·0 N.	Down.	V.	
	,, ,, 26	29·11	...	...	,,	,,	V.N.	−·030547
	,, ,, 28	27·48	...	...	1·8 N.	Down.	V.	
	,, ,, 30	27·47	...	...	,,	,,	V.N.	−·041969
	,, ,, 34	38·19	...	...	1·8 N.	Up.	V.	
	,, ,, 35	38·17	...	...	,,	,,	V.N.	+·041969
	,, ,, 37	36·71	...	...	2·0 N.	Up.	V.	
	,, ,, 38	36·70	...	...	,,	,,	V.N.	+·030547
	,, ,, 40	35·10	88·6	...	2·4 N.	Up.	V.	
	,, ,, 41	35·10	88·2	...	,,	,,	V.N.	+·017641
	,, ,, 49	35·10	88·4	...	2·4 S.	Up.	V.	
	,, ,, 50	35·09	88·3	...	,,	,,	V.N.	+·017641
	,, ,, 53	36·70	...	...	2·0 S.	Up.	V.	
	,, ,, 54	36·70	...	...	,,	,,	V.N.	+·030547
	,, ,, 58	38·29	...	...	1·8 S.	Up.	V.	
	,, ,, 58	38·28	...	...	,,	,,	V.N.	+·041969
	,, 15 6	27·20	...	...	1·8 S.	Down.	V.	
	,, ,, 7	27·21	...	...	,,	,,	V.N.	−·041969
	,, ,, 10	28·84	...	...	2·0 S.	Down.	V.	
	,, ,, 10	28·85	...	...	,,	,,	V.N.	−·030547
	,, ,, 13	30·58	...	...	2·4 S.	Down.	V.	
	,, ,, 14	30·58	...	...	,,	,,	V.N.	−·017641
	,, ,, 21	32·77	88·4	2·50	Away.	...	V.	.....
	,, ,, 22	32·79	88·3	2·52	,,	...	V.N.	.....
	,, ,, 38	32·82	88·5	2·52	,,	...	V.N.	.....

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
V.	d. h. m.							
29th June 1876.	29 15 32	27·20	92·8	3·43	Away.	...	P.	.....
	,, ,, 51	27·32	...	...	5·0 N.	Up.	P.	
	,, ,, 52	27·32	...	...	,,	,,	V.N.	+·001913
	,, ,, 59	27·39	...	...	4·8 N.	Up.	P.	
	,, ,, 59	27·38	...	...	,,	,,	V.N.	+·002162
	,, 16 5	27·49	...	...	4·6 N.	Up.	P.	
	,, ,, 7	27·49	...	...	,,	,,	V.N.	+·002457
	,, ,, 15	27·50	...	...	4·4 N.	Up.	P.	
	,, ,, 16	27·50	...	...	,,	,,	V.N.	+·002808
	,, ,, 27	27·52	...	...	4·2 N.	Up.	P.	
	,, ,, 28	27·52	...	...	,,	,,	V.N.	+·003229
	,, ,, 33	27·60	...	...	4·0 N.	Up.	P.	
	,, ,, 34	27·58	...	...	,,	,,	V.N.	+·003738
	,, ,, 38	27·62	...	...	3·8 N.	Up.	P.	
	,, ,, 39	27·62	...	...	,,	,,	V.N.	+·004361
	,, ,, 46	27·70	...	...	3·6 N.	Up.	P.	
	,, ,, 47	27·69	...	...	,,	,,	V.N.	+·005130
	,, ,, 51	27·78	...	...	3·4 N.	Up.	P.	
	,, ,, 52	27·78	...	...	,,	,,	V.N.	+·006091
	,, ,, 59	27·89	...	...	3·2 N.	Up.	P.	
	,, 17 0	27·88	...	...	,,	,,	V.N.	+·007308
	,, ,, 6	28·02	...	...	3·0 N.	Up.	P.	
	,, ,, 7	28·01	93·0	3·43	,,	,,	V.N.	+·008873
	,, ,, 12	27·90	...	...	3·2 N.	Up.	P.	
	,, ,, 13	27·88	...	...	,,	,,	V.N.	+·007308
	,, ,, 17	27·80	...	...	3·4 N.	Up.	P.	
	,, ,, 18	27·81	...	...	,,	,,	V.N.	+·006091
	,, ,, 22	27·69	...	...	3·6 N.	Up.	P.	
	,, ,, 23	27·69	...	...	,,	,,	V.N.	+·005130
	,, ,, 27	27·61	...	...	3·8 N.	Up.	P.	
	,, ,, 28	27·62	...	...	,,	,,	V.N.	+·004361
	,, ,, 32	27·58	...	...	4·0 N.	Up.	P.	
	,, ,, 33	27·58	...	...	,,	,,	V.N.	+·003738
	,, ,, 36	27·50	...	...	4·2 N.	Up.	P.	
	,, ,, 37	27·51	...	...	,,	,,	V.N.	+·003229
	,, ,, 40	27·49	...	...	4·4 N.	Up.	P.	
	,, ,, 41	27·49	...	...	,,	,,	V.N.	+·002808
	,, ,, 45	27·43	...	...	4·6 N.	Up.	P.	
	,, ,, 46	27·43	...	...	,,	,,	V.N.	+·002457
	,, ,, 50	27·41	...	...	4·8 N.	Up.	P.	
	,, ,, 50	27·41	...	...	,,	,,	V.N.	+·002162
	,, ,, 55	27·39	...	...	5·0 N.	Up.	P.	
	,, ,, 56	27·39	...	...	,,	,,	V.N.	+·001913
	,, 18 0	27·21	93·2	3·43	Away.	...	P.	.....
	,, ,, 2	27·20	...	...	,,	...	V.N.	.....
Va.	30 13 28	27·29	93·0	3·43	Away.	...	P.	.....
30th June 1876.	,, ,, 29	27·29	93·0	3·43	,,	...	V.N.	.....
	,, 14 9	28·02	93·2	3·43	3·0 N.	Up.	P.	
	,, ,, 10	28·02	93·2	3·43	,,	,,	V.N.	+·008873
	,, ,, 21	28·20	...	...	2·8 N.	Up.	P.	
	,, ,, 22	28·20	...	...	,,	,,	V.N.	+·010918
	,, ,, 32	28·43	...	...	2·6 N.	Up.	P.	
	,, ,, 33	28·43	...	...	,,	,,	V.N.	+·013643
	,, ,, 45	28·79	...	...	2·4 N.	Up.	P.	
	,, ,, 46	28·78	...	...	,,	,,	V.N.	+·017358
	,, ,, 53	29·24	...	...	2·2 N.	Up.	P.	
	,, ,, 54	29·23	...	...	,,	,,	V.N.	+·022556
	,, 15 1	29·90	...	...	2·0 N.	Up.	P.	
	,, ,, 2	29·90	...	...	,,	,,	V.N.	+·030057
	,, ,, 9	30·32	...	...	1·9 N.	Up.	P.	
	,, ,, 10	30·34	...	...	,,	,,	V.N.	+·035082
	,, ,, 18	30·90	...	...	1·8 N.	Up.	P.	
	,, ,, 19	30·90	...	...	,,	,,	V.N.	+·041295
	,, ,, 24	31·62	...	...	1·7 N.	Up.	P.	
	,, ,, 25	31·62	...	...	,,	,,	V.N.	+·049069
	,, ,, 32	32·60	...	...	1·60 N.	Up.	P.	
	,, ,, 33	32·60	...	...	,,	,,	V.N.	+·058927
	,, ,, 41	33·88	...	...	1·50 N.	Up.	P.	
	,, ,, 42	33·88	...	...	,,	,,	V.N.	+·071619
	,, ,, 49	34·68	...	...	1·45 N.	Up.	P.	
	,, ,, 50	34·67	...	...	,,	,,	V.N.	+·079353
	,, ,, 56	35·65	...	...	1·40 N.	Up.	P.	
	,, ,, 57	35·65	...	...	,,	,,	V.N.	+·088245
	,, 16 3	36·83	...	...	1·35 N.	Up.	P.	
	,, ,, 4	36·82	...	...	,,	,,	V.N.	+·098520
	,, ,, 9	38·36	...	...	1·30 N.	Up.	P.	
	,, ,, 10	38·37	...	...	,,	,,	V.N.	+·110459
	,, ,, 20	40·38	93·8	3·43	1·25 N.	Up.	P.	
	,, ,, 21	40·39	93·8	3·43	,,	,,	V.N.	+·124414
	,, ,, 32	38·60	...	...	1·30 N.	Up.	P.	
	,, ,, 33	38·60	...	...	,,	,,	V.N.	+·110459

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (F).
	d. h. m.							
Va.								
30th June 1876—*continued.*	30 16 50	37·18	...	...	1·35 N.	Up.	P.	
	,, ,, 51	37·18	...	...	,,	,,	V.N.	+ ·098520
	,, ,, 56	36·00	...	...	1·40 N.	Up.	P.	
	,, ,, 57	36·00	...	...	,,	,,	V.N.	+ ·088245
	,, 17 2	35·02	...	...	1·45 N.	Up.	P.	
	,, ,, 3	35·01	...	...	,,	,,	V.N.	+ ·079353
	,, ,, 7	34·22	...	...	1·50 N.	Up.	P.	
	,, ,, 8	34·21	...	...	,,	,,	V.N.	+ ·071619
	,, ,, 13	32·96	...	...	1·60 N.	Up.	P.	
	,, ,, 14	32·94	...	...	,,	,,	V.N.	+ ·058927
	,, ,, 24	32·00	...	...	1·70 N.	Up.	P.	
	,, ,, 25	32·00	...	...	,,	,,	V.N.	+ ·049069
	,, ,, 30	31·28	...	...	1·80 N.	Up.	P.	
	,, ,, 30	31·27	...	...	,,	,,	V.N.	+ ·041295
	,, ,, 33	30·67	...	...	1·90 N.	Up.	P.	
	,, ,, 34	30·68	...	...	,,	,,	V.N.	+ ·035082
	,, ,, 37	30·20	...	...	2·00 N.	Up.	P.	
	,, ,, 38	30·20	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 41	29·52	...	...	2·20 N.	Up.	P.	
	,, ,, 42	29·50	...	...	,,	,,	V.N.	+ ·022556
	,, ,, 45	29·02	...	...	2·40 N.	Up.	P.	
	,, ,, 46	29·02	...	...	,,	,,	V.N.	+ ·017358
	,, ,, 48	28·70	...	...	2·60 N.	Up.	P.	
	,, ,, 49	28·70	...	...	,,	,,	V.N.	+ ·013643
	,, ,, 55	28·41	...	...	2·80 N.	Up.	P.	
	,, ,, 56	28·40	...	...	,,	,,	V.N.	+ ·010918
	,, ,, 59	28·20	...	...	3·00 N.	Up.	P.	
	,, 18 0	28·21	...	...	,,	,,	V.N.	+ ·008873
	,, ,, 3	27·42	93·9	3·43	Away.	...	P.	.....
	,, ,, 4	27·40	93·9	3·43	,,	...	V.N.	.....
Vb.								
30th June 1876.	30 18 27	27·33	93·9	3·43	Away.	...	P.	.....
	,, ,, 28	27·33	93·9	3·43	,,	...	V.N.	.....
	,, ,, 47	28·10	93·9	3·43	3·00 S.	Up.	P.	
	,, ,, 48	28·09	93·9	3·43	,,	,,	V.N.	+ ·008873
	,, ,, 54	28·30	...	...	2·80 S.	Up.	T.	
	,, ,, 55	28·29	...	...	,,	,,	V.N.	+ ·010918
	,, ,, 59	28·51	...	...	2·60 S.	Up.	T.	
	,, 19 0	28·50	...	...	,,	,,	V.N.	+ ·013643
	,, ,, 7	28·86	...	...	2·40 S.	Up.	T.	
	,, ,, 8	28·87	...	...	,,	,,	V.N.	+ ·017358
	,, ,, 12	29·33	...	...	2·20 S.	Up.	T.	
	,, ,, 13	29·32	...	...	,,	,,	V.N.	+ ·022556
	,, ,, 16	30·02	...	...	2·00 S.	Up.	P.	
	,, ,, 17	30·03	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 22	30·53	...	...	1·90 S.	Up.	P.	
	,, ,, 23	30·53	...	...	,,	,,	V.N.	+ ·035082
	,, ,, 26	31·12	...	...	1·80 S.	Up.	P.	
	,, ,, 27	31·13	...	...	,,	,,	V.N.	+ ·041295
	,, ,, 47	32·12	...	...	1·70 S.	Up.	P.	
	,, ,, 48	32·12	...	...	,,	,,	V.N.	+ ·049069
	,, ,, 55	33·12	...	...	1·60 S.	Up.	P.	
	,, ,, 56	33·12	...	...	,,	,,	V.N.	+ ·058927
	,, 20 2	34·50	...	...	1·50 S.	Up.	P.	
	,, ,, 3	34·50	...	...	,,	,,	V.N.	+ ·071619
	,, ,, 7	35·37	...	...	1·45 S.	Up.	P.	
	,, ,, 8	35·37	...	...	,,	,,	V.N.	+ ·079353
	,, ,, 11	36·39	...	...	1·40 S.	Up.	P.	
	,, ,, 12	36·38	...	...	,,	,,	V.N.	+ ·088245
	,, ,, 18	37·66	...	...	1·35 S.	Up.	P.	
	,, ,, 18	37·66	...	...	,,	,,	V.N.	+ ·098520
	,, ,, 22	39·31	...	...	1·30 S.	Up.	P.	
	,, ,, 23	39·30	...	...	,,	,,	V.N.	+ ·110459
	,, ,, 28	41·59	93·7	3·43	1·25 S.	Up.	P.	
	,, ,, 29	41·60	93·7	3·43	,,	,,	V.N.	+ ·124414
	,, ,, 34	39·50	...	...	1·30 S.	Up.	P.	
	,, ,, 35	39·50	...	...	,,	,,	V.N.	+ ·110459
	,, ,, 40	37·91	...	...	1·35 S.	Up.	P.	
	,, ,, 40	37·90	...	...	,,	,,	V.N.	+ ·098520
	,, ,, 45	36·68	...	...	1·40 S.	Up.	P.	
	,, ,, 46	36·67	...	...	,,	,,	V.N.	+ ·088245
	,, ,, 48	35·61	...	...	1·45 S.	Up.	P.	
	,, ,, 49	35·61	...	...	,,	,,	V.N.	+ ·079353
	,, ,, 50	34·80	...	...	1·50 S.	Up.	P.	
	,, ,, 50	34·79	...	...	,,	,,	V.N.	+ ·071619
	,, ,, 54	33·41	...	...	1·60 S.	Up.	P.	
	,, ,, 54	33·40	...	...	,,	,,	V.N.	+ ·058927
	,, 21 8	32·43	...	...	1·70 S.	Up.	P.	
	,, ,, 9	32·43	...	...	,,	,,	V.N.	+ ·049069
	,, ,, 14	31·68	...	...	1·80 S.	Up.	P.	
	,, ,, 15	31·69	...	...	,,	,,	V.N.	+ ·041295
	,, ,, 19	30·98	...	...	1·90 S.	Up.	P.	
	,, ,, 19	30·98	...	...	,,	,,	V.N.	+ ·035082

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (F).
	d. h. m.							
Vb.								
30th June 1876—*continued.*	30 21 21	30·50	...	...	2·00 S.	Up.	P.	
	,, ,, 21	30·50	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 23	29·80	...	...	2·20 S.	Up.	P.	
	,, ,, 24	29·79	...	...	,,	,,	V.N.	+ ·022556
	,, ,, 37	29·29	...	...	2·40 S.	Up.	P.	
	,, ,, 38	29·29	...	...	,,	,,	V.N.	+ ·017358
	,, ,, 40	28·90	...	...	2·60 S.	Up.	P.	
	,, ,, 41	28·91	...	...	,,	,,	V.N.	+ ·013643
	,, ,, 43	28·68	...	...	2·80 S.	Up.	P.	
	,, ,, 44	28·68	...	...	,,	,,	V.N.	+ ·010918
	,, ,, 46	28·40	...	...	3·00 S.	Up.	P.	
	,, ,, 47	28·40	...	...	,,	,,	V.N.	+ ·008873
	,, ,, 54	27·60	93·7	3·43	Away.	...	P.	.....
	,, ,, 55	27·60	93·7	3·43	,,	...	V.N.	.....
Vc.								
3rd July 1876.	3 15 33	27·19	92·3	3·45	Away.	...	P.	.....
	,, ,, 34	27·20	92·3	3·45	,,	...	V.N.	.....
	,, ,, 38	25·19	...	...	2·4 N.	Down.	P.	
	,, ,, 39	25·29	...	...	,,	,,	V.N.	— ·017358
	,, ,, 43	23·50	...	...	2·0 N.	Down.	P.	
	,, ,, 44	23·51	...	...	,,	,,	V.N.	— ·030057
	,, ,, 46	21·81	...	...	1·8 N.	Down.	P.	
	,, ,, 47	21·81	...	...	,,	,,	V.N.	— ·041295
	,, ,, 56	31·20	...	...	1·8 N.	Up.	P.	
	,, ,, 57	31·19	...	...	,,	,,	V.N.	+ ·041295
	,, 16 0	30·19	...	...	2·0 N.	Up.	P.	
	,, ,, 1	30·19	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 3	29·00	...	...	2·4 N.	Up.	P.	
	,, ,, 4	29·01	...	...	,,	,,	V.N.	+ ·017358
	,, ,, 8	27·28	92·3	3·45	Away.	...	P.	.....
	,, ,, 9	27·28	92·3	3·45	,,	...	V.N.	.....
	,, ,, 13	25·09	...	...	2·4 S.	Down.	P.	
	,, ,, 14	25·09	...	...	,,	,,	V.N.	— ·017358
	,, ,, 16	23·30	...	...	2·0 S.	Down.	P.	
	,, ,, 17	23·29	...	...	,,	,,	V.N.	— ·030057
	,, ,, 19	21·48	...	...	1·8 S.	Down.	P.	
	,, ,, 20	21·47	...	...	,,	,,	V.N.	— ·041295
	,, ,, 28	31·29	...	...	1·8 S.	Up.	P.	
	,, ,, 29	31·29	...	...	,,	,,	V.N.	+ ·041295
	,, ,, 32	30·21	...	...	2·0 S.	Up.	P.	
	,, ,, 33	30·21	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 35	29·00	...	...	2·4 S.	Up.	P.	
	,, ,, 36	29·00	...	...	,,	,,	V.N.	+ ·017358
	,, ,, 40	27·21	92·9	3·45	Away.	...	P.	.....
	,, ,, 41	27·21	92·9	3·45	,,	...	V.N.	.....
VI.								
18th August 1876.	8 10 54	34·53	90·8	2·36	Away.	...	P.	.....
	,, ,, 56	34·53	90·8	2·36	,,	...	V.N.	.....
	,, 11 12	33·59	90·9	2·36	3·0 N.	Down.	P.	
	,, ,, 13	33·60	90·9	2·38	,,	,,	V.N.	— ·008873
	,, ,, 16	32·92	...	...	2·5 N.	Down.	P.	
	,, ,, 17	32·92	...	...	,,	,,	V.N.	— ·015352
	,, ,, 20	31·39	...	...	2·0 N.	Down.	P.	
	,, ,, 21	31·38	...	...	,,	,,	V.N.	— ·030057
	,, ,, 25	26·11	...	...	1·5 N.	Down.	P.	
	,, ,, 26	26·11	...	...	,,	,,	V.N.	— ·071619
	,, ,, 32	43·32	...	...	1·5 N.	Up.	P.	
	,, ,, 33	43·32	...	...	,,	,,	V.N.	+ ·071619
	,, ,, 37	37·81	...	...	2·0 N.	Up.	P.	
	,, ,, 38	37·81	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 42	36·20	...	...	2·5 N.	Up.	P.	
	,, ,, 43	36·19	...	...	,,	,,	V.N.	+ ·015352
	,, ,, 47	35·51	91·2	2·36	3·0 N.	Up.	P.	
	,, ,, 47	35·50	91·2	2·36	,,	,,	V.N.	+ ·008873
	,, ,, 49	34·57	...	...	Away.	...	P.	
	,, ,, 50	34·57	...	...	,,	...	V.N.	
	,, 12 4	35·42	...	...	3·0 S.	Up.	P.	
	,, ,, 5	35·41	...	...	,,	,,	V.N.	+ ·008873
	,, ,, 9	36·11	...	...	2·5 S.	Up.	P.	
	,, ,, 10	36·12	...	...	,,	,,	V.N.	+ ·015352
	,, ,, 13	37·80	...	...	2·0 S.	Up.	P.	
	,, ,, 14	37·80	...	...	,,	,,	V.N.	+ ·030057
	,, ,, 25	43·83	...	...	1·5 S.	Up.	P.	
	,, ,, 26	43·83	...	...	,,	,,	P.N.	+ ·071619
	,, ,, 34	25·94	...	...	1·5 S.	Down.	P.	
	,, ,, 35	25·93	...	...	,,	,,	V.N.	— ·071619
	,, ,, 40	31·31	...	...	2·0 S.	Down.	P.	
	,, ,, 41	31·31	...	...	,,	,,	V.N.	— ·030057
	,, ,, 46	32·93	...	...	2·5 S.	Down.	P.	
	,, ,, 47	32·93	...	...	,,	,,	V.N.	— ·015352
	,, ,, 54	33·65	...	...	3·0 S.	Down.	P.	
	,, ,, 55	33·65	...	...	,,	,,	V.N.	— ·008873
	,, ,, 58	34·57	91·2	2·36	Away.	...	P.	.....
	,, ,, 59	34·58	91·2	2·36	,,	...	V.N.	.....

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.	Disturbing force (Y).
VII. 3rd May 1877.	d. h. m.							
	3 13 54	34·89	91·0	2·42	Away.	...	P.	.....
	,, ,, 55	34·89	91·0	2·42	,,	...	T.	.....
	,, 14 4	34·01	...	...	3·0 N.	Down.	P.	−·008822
	,, ,, 5	34·00	...	...	,,	,,	T.	
	,, ,, 8	33·40	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 9	33·40	...	...	,,	,,	T.	
	,, ,, 13	31·96	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 14	31·94	...	...	,,	,,	T.	
	,, ,, 20	27·06	...	...	1·5 N.	Down.	P.	−·071208
	,, ,, 21	27·06	...	...	,,	,,	T.	
	,, ,, 31	43·49	...	...	1·5 N.	Up.	P.	+·071208
	,, ,, 32	43·49	...	...	,,	,,	T.	
	,, ,, 35	38·05	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 36	38·06	...	...	,,	,,	T.	
	,, ,, 38	36·48	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 39	36·46	...	...	,,	,,	T.	
	,, ,, 42	35·81	91·3	2·42	3·0 N.	Up.	P.	+·008822
	,, ,, 43	35·79	91·3	2·42	,,	,,	T.	
	,, ,, 45	34·90	...	...	Away.	...	P.	.....
	,, ,, 48	35·78	...	...	3·0 S.	Up.	P.	+·008822
	,, ,, 49	35·79	...	...	,,	,,	T.	
	,, ,, 54	36·41	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 55	36·40	...	...	,,	,,	T.	
	,, ,, 58	38·02	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 59	38·01	...	...	,,	,,	T.	
	,, 15 8	43·86	...	...	1·5 S.	Up.	P.	+·071208
	,, ,, 9	43·87	...	...	,,	,,	T.	
	,, ,, 18	26·89	...	...	1·5 S.	Down.	P.	−·071208
	,, ,, 19	26·90	...	...	,,	,,	T.	
	,, ,, 24	31·76	...	...	2·0 S.	Down.	P.	−·029884
	,, ,, 25	31·75	...	...	,,	,,	T.	
	,, ,, 28	33·28	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 29	33·26	...	...	,,	,,	T.	
	,, ,, 31	33·92	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 32	33·93	...	...	,,	,,	T.	
	,, ,, 34	34·81	91·5	2·42	Away.	...	P.	.....
	,, ,, 35	34·81	91·5	2·42	,,	...	T.	.....
VIII. 10th November 1877.	10 11 58	35·12	92·2	2·47	Away.	...	P.	.....
	,, ,, 59	35·12	92·2	2·47	,,	...	V.N.	.....
	,, 12 6	34·31	...	...	3·0 N.	Down.	P.	−·008822
	,, ,, 7	34·31	...	...	,,	,,	V.N.	
	,, ,, 12	33·69	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 13	33·69	...	...	,,	,,	V.N.	
	,, ,, 16	33·50	...	...	2·4 N.	Down.	P.	−·017259
	,, ,, 17	33·49	...	...	,,	,,	V.N.	
	,, ,, 20	32·20	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 21	32·21	...	...	,,	,,	V.N.	
	,, ,, 24	31·00	...	...	1·8 N.	Down.	P.	−·041058
	,, ,, 25	31·01	...	...	,,	,,	V.N.	
	,, ,, 36	39·46	...	...	1·8 N.	Up.	P.	+·041058
	,, ,, 37	39·47	...	...	,,	,,	V.N.	
	,, ,, 40	38·21	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 41	38·21	...	...	,,	,,	V.N.	
	,, ,, 46	36·90	...	...	2·4 N.	Up.	P.	+·017259
	,, ,, 47	36·89	...	...	,,	,,	V.N.	
	,, ,, 51	36·69	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 52	36·70	...	...	,,	,,	V.N.	
	,, ,, 55	36·01	92·6	2·47	3·0 N	Up.	P.	+·008822
	,, ,, 56	36·00	92·6	2·47	,,	,,	V.N.	
	,, 13 3	36·00	...	...	3·0 S.	Up.	P.	+·008822
	,, ,, 4	35·99	...	...	,,	,,	V.N.	
	,, ,, 7	36·66	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 8	36·67	...	...	,,	,,	V.N.	
	,, ,, 12	36·87	...	...	2·4 S.	Up.	P.	+·017259
	,, ,, 13	36·87	...	...	,,	,,	V.N.	
	,, ,, 18	38·20	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 19	38·20	...	...	,,	,,	V.N.	
	,, ,, 23	39·52	...	...	1·8 S.	Up.	P.	+·041058
	,, ,, 24	39·53	...	...	,,	,,	V.N.	
	,, ,, 32	30·93	...	...	1·8 S.	Down.	P.	−·041058
	,, ,, 33	30·93	...	...	,,	,,	V.N.	
	,, ,, 37	32·10	...	...	2·0 S.	Down.	P.	−·029884
	,, ,, 38	32·10	...	...	,,	,,	V.N.	
	,, ,, 42	33·35	...	...	2·4 S.	Down.	P.	−·017259
	,, ,, 43	33·36	...	...	,,	,,	V.N.	
	,, ,, 46	33·54	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 47	33·54	...	...	,,	,,	V.N.	
	,, ,, 51	34·20	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 52	34·20	...	...	,,	,,	V.N.	
	,, ,, 54	35·05	92·6	2·47	Away.	...	P.	.....
	,, ,, 55	35·05	...	...	,,	...	V.N.	.....

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.	Disturbing force (Y).
IXa. 8th February 1879.	d. h. m.							
	8 13 32	35·88	87·4	2·65	Away.	...	P.	.....
	,, ,, 33	35·88	87·4	2·65	,,	...	V.D.	.....
	,, ,, 40	34·89	...	...	3·0 N.	Down.	P.	−·008822
	,, ,, 41	34·89	...	...	,,	,,	V.D.	
	,, ,, 47	36·83	...	...	3·0 N.	Up.	P.	+·008822
	,, ,, 48	36·84	...	...	,,	,,	V.D.	
	,, ,, 52	35·88	...	...	Away.	...	P.	.....
	,, ,, 53	35·88	...	...	,,	...	V.D.	.....
	,, ,, 59	36·83	...	...	3·0 S.	Up.	P.	+·008822
	,, 14 0	36·83	...	...	,,	,,	V.D.	
	,, ,, 7	34·88	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 8	34·89	...	...	,,	,,	V.D.	
	,, ,, 15	35·81	87·5	2·65	Away.	...	P.	.....
	,, ,, 16	35·80	87·5	2·65	,,	...	V.D.	.....
	,, ,, 26	34·10	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 27	34·10	...	...	,,	,,	V.D.	
	,, ,, 36	37·60	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 37	37·61	...	...	,,	,,	V.D.	
	,, ,, 42	35·87	...	...	Away.	...	P.	.....
	,, ,, 43	35·88	...	...	,,	...	V.D.	.....
	,, ,, 48	37·51	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 49	37·51	...	...	,,	,,	V.D.	
	,, ,, 57	34·18	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 58	34·17	...	...	,,	,,	V.D.	
	,, 15 1	35·76	...	...	Away.	...	P.	.....
	,, ,, 2	35·76	...	...	,,	...	V.D.	.....
	,, ,, 10	33·70	87·6	2·65	2·3 N.	Down.	P.	−·019617
	,, ,, 11	33·70	87·6	2·65	,,	,,	V.D.	
	,, ,, 25	38·02	...	...	2·3 N.	Up.	P.	+·019617
	,, ,, 26	38·03	...	...	,,	,,	V.D.	
	,, ,, 31	35·81	...	...	Away.	...	P.	.....
	,, ,, 32	35·82	...	...	,,	...	V.D.	.....
	,, ,, 38	38·01	...	...	2·3 S.	Up.	P.	+·019617
	,, ,, 39	38·02	...	...	,,	,,	V.D.	
	,, ,, 49	33·61	...	...	2·3 S.	Down.	P.	−·019617
	,, ,, 50	33·61	...	...	,,	,,	V.D.	
	,, ,, 54	35·71	...	...	Away.	...	P.	.....
	,, ,, 55	35·71	...	...	,,	...	V.D.	.....
	,, 16 3	32·43	87·6	2·65	2·0 S.	Down.	P.	−·029884
	,, ,, 4	32·43	87·6	2·65	,,	,,	V.D.	
	,, ,, 16	39·32	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 17	39·32	...	...	,,	,,	V.D.	
	,, ,, 25	35·80	...	...	Away.	...	P.	.....
	,, ,, 26	35·80	...	...	,,	...	V.D.	.....
	,, ,, 30	39·20	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 31	39·20	...	...	,,	,,	V.D.	
	,, ,, 39	32·49	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 40	32·49	...	...	,,	,,	V.D.	
	,, ,, 45	35·62	...	...	Away.	...	P.	.....
	,, ,, 46	35·62	...	...	,,	...	V.D.	.....
	,, ,, 52	31·11	87·7	2·65	1·8 N.	Down.	P.	−·041058
	,, ,, 53	31·12	87·7	2·65	,,	,,	V.D.	
	,, 17 7	40·59	...	...	1·8 N.	Up.	P.	+·041058
	,, ,, 8	40·60	...	...	,,	,,	G.N.	
	,, ,, 15	35·67	...	...	Away.	...	P.	.....
	,, ,, 16	35·66	...	...	,,	...	G.N.	.....
	,, ,, 28	40·70	...	...	1·8 S.	Up.	P.	+·041058
	,, ,, 29	40·70	...	...	,,	,,	V.D.	
	,, ,, 41	30·99	88·0	2·65	1·8 S.	Down.	P.	−·041058
	,, ,, 42	30·99	87·9	2·65	,,	,,	V.D.	
	,, ,, 48	35·54	...	...	Away.	...	P.	.....
	,, ,, 49	35·55	...	...	,,	...	V.D.	.....
IXb. 10th February 1879.	10 13 29	35·45	87·8	2·67	Away.	...	P.	.....
	,, ,, 30	35·45	87·8	2·67	,,	...	V.D.	.....
	,, ,, 46	34·51	...	...	3·0 N.	Down.	P.	−·008822
	,, ,, 47	34·51	...	...	,,	,,	V.D.	
	,, ,, 57	36·51	...	...	3·0 N.	Up.	P.	+·008822
	,, ,, 58	36·51	...	...	,,	,,	V.D.	
	,, 14 5	35·60	...	...	Away.	...	P.	.....
	,, ,, 6	35·60	...	...	,,	...	V.D.	.....
	,, ,, 11	36·55	...	...	3·0 S.	Up.	P.	+·008822
	,, ,, 12	36·55	...	...	,,	,,	V.D.	
	,, ,, 19	34·60	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 20	34·60	...	...	,,	,,	V.D.	
	,, ,, 27	35·54	88·0	2·67	Away.	...	P.	.....
	,, ,, 28	35·53	88·0	2·67	,,	...	V.D.	.....
	,, ,, 35	33·88	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 36	33·88	...	...	,,	,,	V.D.	
	,, ,, 44	37·25	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 45	37·25	...	...	,,	,,	V.D.	
	,, ,, 50	35·52	...	...	Away.	...	P.	.....
	,, ,, 51	35·53	...	...	,,	...	V.D.	.....

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (*Y*).
IXb.	d. h. m.							
10th February 1879—*continued.*	10 14 56	37·22	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 57	37·22	...	...	,,	,,	V.D.	
	,, 15 4	33·88	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 5	33·88	...	...	,,	,,	V.D.	
	,, ,, 10	35·48	88·0	2·67	Away.	...	P.	.....
	,, ,, 11	35·48	88·0	2·67	,,	...	V.D.	.....
	,, ,, 16	33·36	...	...	2·3 N.	Down.	P.	−·019617
	,, ,, 17	33·27	...	...	,,	,,	V.D.	
	,, ,, 23	37·71	...	...	2·3 N.	Up.	P.	+·019617
	,, ,, 24	37·71	...	...	,,	,,	V.D.	
	,, ,, 28	35·53	...	...	Away.	...	P.	.....
	,, ,, 29	35·54	...	...	,,	...	V.D.	.....
	,, ,, 40	37·80	...	...	2·3 S.	Up.	P.	+·019617
	,, ,, 41	37·79	...	...	,,	,,	V.D.	
	,, ,, 49	33·33	...	...	2·3 S.	Down.	P.	−·019617
	,, ,, 50	35·33	...	...	,,	,,	V.D.	
	,, ,, 57	35·44	88·1	2·67	Away.	...	P.	.....
	,, ,, 58	35·45	88·0	2·67	,,	...	V.D.	.....
	,, 16 4	32·11	...	...	2·0 S.	Down.	P.	−·029884
	,, ,, 5	32·12	...	...	,,	,,	V.D.	
	,, ,, 14	38·97	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 15	38·98	...	...	,,	,,	V.D.	
	,, ,, 19	35·50	...	...	Away.	...	P.	.....
	,, ,, 20	35·51	...	...	,,	...	V.D.	.....
	,, ,, 25	38·90	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 26	38·90	...	...	,,	,,	V.D.	
	,, ,, 34	32·19	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 35	32·20	...	...	,,	,,	V.D.	
	,, ,, 39	35·31	88·1	2·67	Away.	...	P.	.....
	,, ,, 40	35·31	88·1	2·67	,,	...	V.D.	.....
	,, ,, 45	30·88	...	...	1·8 N.	Down.	P.	−·041058
	,, ,, 46	30·87	...	...	,,	,,	V.D.	
	,, ,, 57	40·40	...	...	1·8 N.	Up.	P.	+·041058
	,, ,, 58	40·39	...	...	,,	,,	V.D.	
	,, 17 4	35·49	...	...	Away.	...	P.	.....
	,, ,, 5	35·49	...	...	,,	...	V.D.	.....
	,, ,, 9	40·48	...	...	1·8 S.	Up.	P.	+·041058
	,, ,, 10	40·49	...	...	,,	,,	V.D.	
	,, ,, 23	30·78	...	...	1·8 S.	Down.	P.	−·041058
	,, ,, 24	30·78	...	...	,,	,,	V.D.	
	,, ,, 30	35·31	88·2	2·67	Away.	...	P.	.....
	,, ,, 31	35·31	88·2	2·67	,,	...	V.D.	.....
X.								
12th January 1880.	12 10 15	36·29	84·2	2·90	Away.	...	P.	.....
	,, ,, 16	36·28	84·2	2·90	,,	...	V.D.	.....
	,, ,, 29	35·30	...	...	3·0 N.	Down.	P.	−·008822
	,, ,, 30	35·30	...	...	,,	,,	V.D.	
	,, ,, 37	37·21	...	...	3·0 N.	Up.	P.	+·008822
	,, ,, 38	37·21	...	...	,,	,,	V.D.	
	,, ,, 43	36·30	...	...	Away.	...	P.	.....
	,, ,, 44	36·29	...	...	,,	...	V.D.	.....
	,, ,, 49	37·21	...	...	3·0 S.	Up.	P.	+·008822
	,, ,, 50	37·21	...	...	,,	,,	V.D.	
	,, ,, 58	35·30	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 59	35·30	...	...	,,	,,	V.D.	
	,, 11 5	36·12	84·3	2·90	Away.	...	P.	.....
	,, ,, 6	36·13	84·3	2·90	,,	...	V.D.	.....
	,, ,, 12	34·42	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 13	34·41	...	...	,,	,,	V.D.	
	,, ,, 21	37·95	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 22	37·96	...	...	,,	,,	V.D.	
	,, ,, 28	36·20	...	...	Away.	...	P.	.....
	,, ,, 29	36·20	...	...	,,	...	V.D.	.....
	,, ,, 37	38·01	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 38	38·00	...	...	,,	,,	V.D.	
	,, ,, 46	34·42	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 47	34·41	...	...	,,	,,	V.D.	
	,, ,, 55	36·09	84·3	2·90	Away.	...	P.	.....
	,, ,, 56	36·10	84·4	2·90	,,	...	V.D.	.....
	,, 12 5	35·94	...	...	2·3 N.	Down.	P.	−·019617
	,, ,, 6	33·93	...	...	,,	,,	V.D.	
	,, ,, 13	36·51	...	...	2·3 N.	Up.	P.	+·019617
	,, ,, 14	38·51	...	...	,,	,,	V.D.	
	,, ,, 18	36·21	...	...	Away.	...	P.	.....
	,, ,, 19	36·21	...	...	,,	...	V.D.	.....
	,, ,, 28	38·64	...	...	2·3 S.	Up.	P.	+·019617
	,, ,, 29	38·64	...	...	,,	,,	V.D.	
	,, ,, 36	33·97	...	...	2·3 S.	Down.	P.	−·019617
	,, ,, 37	33·95	...	...	,,	,,	V.D.	
	,, ,, 45	36·15	84·5	2·90	Away.	...	P.	.....
	,, ,, 46	36·14	84·5	2·90	,,	...	V.D.	.....

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (*Y*).
X.	d. h. m.							
12th January 1880—*continued.*	12 12 53	32·65	...	...	2·0 S.	Down.	P.	−·029884
	,, ,, 54	32·64	...	...	,,	,,	V.D.	
	,, 13 0	40·10	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 1	40·09	...	...	,,	,,	V.D.	
	,, ,, 6	36·23	...	...	Away.	...	P.	.....
	,, ,, 7	36·23	...	...	,,	...	V.D.	.....
	,, ,, 12	40·02	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 13	40·02	...	...	,,	,,	V.D.	
	,, ,, 20	32·76	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 21	32·75	...	...	,,	,,	V.D.	
	,, ,, 27	36·11	84·6	2·90	Away.	...	P.	.....
	,, ,, 28	36·11	84·6	2·90	,,	...	V.D.	.....
	,, ,, 32	31·30	...	...	1·8 N.	Down.	P.	−·041058
	,, ,, 33	31·30	...	...	,,	,,	V.D.	
	,, ,, 40	41·64	...	...	1·8 N.	Up.	P.	+·041058
	,, ,, 41	41·65	...	...	,,	,,	V.D.	
	,, ,, 46	36·17	...	...	Away.	...	P.	.....
	,, ,, 47	36·18	...	...	,,	...	V.D.	.....
	,, ,, 56	41·80	...	...	1·8 S.	Up.	P.	+·041058
	,, ,, 57	41·80	...	...	,,	,,	V.D.	
	,, 14 5	31·01	...	...	1·8 S.	Down.	P.	−·041058
	,, ,, 6	31·02	...	...	,,	,,	V.D.	
	,, ,, 10	35·91	84·8	2·90	Away.	...	P.	.....
	,, ,, 11	35·90	84·8	2·90	,,	...	V.D.	.....
XI.								
16th April 1880.	16 12 2	29·80	88·6	1·52	Away.	...	P.	
	,, ,, 3	29·81	88·7	1·52	,,	...	V.D.	
	,, ,, 16	29·22	88·7	1·52	3·0 N.	Down.	P.	−·008822
	,, ,, 18	29·22	88·7	1·52	,,	,,	V.D.	
	,, ,, 26	30·41	...	...	3·0 N.	Up.	P.	+·008822
	,, ,, 27	30·40	...	...	,,	,,	V.D.	
	,, ,, 31	29·83	...	...	Away.	...	P.	.....
	,, ,, 32	29·82	...	...	,,	...	V.D.	.....
	,, ,, 37	30·43	...	...	3·0 S.	Up.	P.	+·008822
	,, ,, 38	30·43	...	...	,,	,,	V.D.	
	,, ,, 43	29·24	...	...	3·0 S.	Down.	P.	−·008822
	,, ,, 44	29·24	...	...	,,	,,	V.D.	
	,, ,, 48	29·82	88·8	1·52	Away.	...	P.	.....
	,, ,, 49	29·82	88·8	1·52	,,	...	V.D.	.....
	,, ,, 56	28·80	...	...	2·5 S.	Down.	P.	−·015264
	,, ,, 57	28·79	...	...	,,	,,	V.D.	
	,, 13 2	30·88	...	...	2·5 S.	Up.	P.	+·015264
	,, ,, 3	30·88	...	...	,,	,,	V.D.	
	,, ,, 8	29·86	...	...	Away.	...	P.	.....
	,, ,, 9	29·85	...	...	,,	...	V.D.	.....
	,, ,, 17	30·89	...	...	2·5 N.	Up.	P.	+·015264
	,, ,, 18	30·90	...	...	,,	,,	V.D.	
	,, ,, 25	28·90	...	...	2·5 N.	Down.	P.	−·015264
	,, ,, 26	28·90	...	...	,,	,,	V.D.	
	,, ,, 30	29·88	88·9	1·52	Away.	...	P.	.....
	,, ,, 31	29·88	88·9	1·52	,,	...	V.D.	.....
	,, ,, 35	28·60	...	...	2·3 N.	Down.	P.	−·019617
	,, ,, 36	28·59	...	...	,,	,,	V.D.	
	,, ,, 43	31·19	...	...	2·3 N.	Up.	P.	+·019617
	,, ,, 44	31·20	...	...	,,	,,	V.D.	
	,, ,, 50	29·92	...	...	Away.	...	P.	.....
	,, ,, 51	29·92	...	...	,,	...	V.D.	.....
	,, 14 2	31·24	...	...	2·3 S.	Up.	P.	+·019617
	,, ,, 3	31·23	...	...	,,	,,	V.D.	
	,, ,, 10	28·62	...	...	2·3 S.	Down.	P.	−·019617
	,, ,, 11	28·62	...	...	,,	,,	V.D.	
	,, ,, 18	29·92	89·1	1·52	Away.	...	P.	.....
	,, ,, 19	29·93	89·0	1·52	,,	...	V.D.	.....
	,, ,, 28	27·85	...	...	2·0 S.	Down.	P.	−·029884
	,, ,, 29	27·84	...	...	,,	,,	V.D.	
	,, ,, 40	31·96	...	...	2·0 S.	Up.	P.	+·029884
	,, ,, 41	31·95	...	...	,,	,,	V.D.	
	,, ,, 45	29·96	...	...	Away.	...	P.	.....
	,, ,, 46	29·96	...	...	,,	...	V.D.	.....
	,, ,, 51	31·95	...	...	2·0 N.	Up.	P.	+·029884
	,, ,, 52	31·95	...	...	,,	,,	V.D.	
	,, ,, 58	27·94	...	...	2·0 N.	Down.	P.	−·029884
	,, ,, 59	27·94	...	...	,,	,,	V.D.	
	,, 15 5	29·94	89·2	1·52	Away.	...	P.	.....
	,, ,, 6	29·95	89·2	1·52	,,	...	V.D.	.....
	,, ,, 11	27·15	...	...	1·8 N.	Down.	P.	−·041058
	,, ,, 12	27·85	...	...	,,	,,	V.D.	
	,, ,, 18	32·72	...	...	1·8 N.	Up.	P.	+·041058
	,, ,, 19	32·73	...	...	,,	,,	V.D.	
	,, ,, 25	29·98	...	...	Away.	...	P.	.....
	,, ,, 26	29·98	...	...	,,	...	V.D.	.....

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
XI. 16th April 1880—*cont.*	d. h. m.							
	16 15 31	32·82	...	...	1·8 S.	Up.	P.	+·041058
	,, ,, 32	32·82	...	...	,,	,,	V.D.	
	,, ,, 39	27·08	...	...	1·8 S.	Down.	P.	−·041058
	,, ,, 40	27·09	...	...	,,	,,	V.D.	
	,, ,, 45	29·96	89·3	1·52	Away.	...	P.	.....
	,, ,, 46	29·95	89·3	1·52	,,	...	V.D.	.....
XII. 10th January 1881.†	10 18 48	28·66*	85·2	1·76	Away.	...	P.	.....
	,, 19 1	28·01	85·2	1·76	3·0 N.	Down.	P.	−·008741
	,, ,, 14	29·27	...	...	3·0 N.	Up.	P.	+·008741
	,, ,, 27	28·67	...	...	Away.	...	P.	.....
	,, ,, 41	29·28	...	...	3·0 S.	Up.	P.	+·008741
	,, ,, 55	28·02	...	...	3·0 S.	Down.	P.	−·008741
	,, 20 7	28·61	...	...	Away.	...	P.	.....
	,, ,, 21	27·49	85·3	1·76	2·5 S.	Down.	P.	−·015012
	,, ,, 36	29·64	...	...	2·5 S.	Up.	P.	+·015012
	,, ,, 50	28·60	...	...	Away.	...	P.	.....
	,, 21 4	29·65	...	...	2·5 N.	Up.	P.	+·015012
	,, ,, 17	27·51	...	...	2·5 N.	Down.	P.	−·015012
	,, ,, 29	28·59	85·4	1·76	Away.	...	P.	.....
	,, ,, 43	27·17	85·5	1·76	2·3 N.	Down.	V.N.	−·019439
	,, 22 1	29·89	...	...	2·3 N.	Up.	V.N.	+·019439
	,, ,, 15	28·55	...	...	Away.	...	V.N.	.....
	,, ,, 31	29·91	...	...	2·3 S.	Up.	V.N.	+·019439
	,, ,, 47	27·10	...	...	2·3 S.	Down.	V.N.	−·019439
	,, 23 0	28·49	86·1	1·76	Away.	...	V.N.	.....
	,, ,, 14	26·33	...	...	2·0 S.	Down.	V.N.	−·029612
	,, ,, 30	30·69	...	...	2·0 S.	Up.	V.N.	+·029612
	,, ,, 47	28·59	...	...	Away.	...	V.N.	.....
	11 0 6	30·69	...	...	2·0 N.	Up.	V.	+·029612
	,, ,, 22	26·40	...	...	2·0 N.	Down.	V.	−·029612
	,, ,, 43	28·52	86·6	1·76	Away.	...	V.	.....
	,, ,, 58	25·57	...	...	1·8 N.	Down.	V.	−·040684
	,, 1 13	31·49	...	...	1·8 N.	Up.	V.	+·040684
	,, ,, 29	28·57	...	...	Away.	...	V.	.....
	,, ,, 47	31·57	...	...	1·8 S.	Up.	V.	+·040684
	,, 2 6	25·40	...	...	1·8 S.	Down.	V.	−·040684
	,, ,, 16	28·42	86·9	1·76	Away.	...	V.	.....
XIII. 4th March 1881.	4 18 20	29·16	86·4	2·40	Away.	...	P.	.....
	,, ,, 35	28·23	...	...	3·0 N.	Down.	P.	−·008266
	,, ,, 47	30·08	...	...	3·0 N.	Up.	P.	+·008266
	,, ,, 59	29·19	...	...	Away.	...	P.	.....
	,, 19 13	30·07	...	...	3·0 S.	Up.	P.	+·008266
	,, ,, 28	28·28	...	...	3·0 S.	Down.	P.	−·008266
	,, ,, 42	29·17	86·5	2·40	Away.	...	P.	.....
	,, ,, 58	27·51	...	...	2·5 S.	Down.	P.	−·014510
	,, 20 12	30·69	...	...	2·5 S.	Up.	P.	+·014510
	,, ,, 26	29·16	...	...	Away.	...	P.	.....
	,, ,, 40	30·65	...	...	2·5 N.	Up.	P.	+·014510
	,, ,, 54	27·53	...	...	2·5 N.	Down.	P.	−·014510
	,, 21 9	29·12	86·6	2·40	Away.	...	P.	.....
	,, ,, 25	27·01	...	...	2·3 N.	Down.	V.N.	−·018811
	,, ,, 40	31·09	...	...	2·3 N.	Up.	V.N.	+·018811
	,, ,, 55	29·16	...	...	Away.	...	V.N.	.....
	,, 22 18	31·13	...	...	2·3 S.	Up.	V.N.	+·018811
	,, ,, 33	27·08	...	...	2·3 S.	Down.	V.N.	−·018811
	,, ,, 49	29·11	86·7	2·40	Away.	...	V.N.	.....
	,, 23 6	25·85	...	...	2·0 S.	Down.	V.N.	−·029191
	,, ,, 24	32·15	...	...	2·0 S.	Up.	V.N.	+·029191
	,, ,, 37	29·19	...	...	Away.	...	V.N.	.....
	,, ,, 55	32·16	...	...	2·0 N.	Up.	V.	+·029191
	5 0 12	25·99	...	...	2·0 N.	Down.	V.	−·029191
	,, ,, 27	29·13	86·8	2·40	Away.	...	V.	.....
	,, ,, 45	24·56	...	...	1·8 N.	Down.	V.	−·040842
	,, 1 2	33·20	...	...	1·8 N.	Up.	V.	+·040842
	,, ,, 19	29·14	...	...	Away.	...	V.	.....
	,, ,, 38	33·35	...	...	1·8 S.	Up.	V.	+·040842
	,, ,, 56	24·38	...	...	1·8 S.	Down.	V.	−·040842
	,, 2 8	29·21	87·1	2·40	Away.	...	V.	.....

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
XIV. 14th May 1881.	d. h. m.							
	14 18 16	28·10	89·7	2·42	Away.	...	P.	.....
	,, ,, 33	27·21	...	...	3·0 N.	Down.	P.	−·008266
	,, ,, 49	28·91	...	...	3·0 N.	Up.	P.	+·008266
	,, 19 2	28·10	...	...	Away.	...	P.	.....
	,, ,, 16	28·91	...	...	3·0 S.	Up.	P.	+·008266
	,, ,, 28	27·21	...	...	3·0 S.	Down.	P.	−·008266
	,, ,, 42	28·07	89·7	2·42	Away.	...	P.	.....
	,, ,, 58	26·52	...	...	2·5 S.	Down.	P.	−·014510
	,, 20 13	29·51	...	...	2·5 S.	Up.	P.	+·014510
	,, ,, 27	28·09	...	...	Away.	...	P.	.....
	,, ,, 41	29·52	...	...	2·5 N.	Up.	P.	+·014510
	,, ,, 55	26·57	...	...	2·5 N.	Down.	P.	−·014510
	,, 21 8	28·10	89·8	2·42	Away.	...	P.	.....
	,, ,, 22	26·12	...	...	2·3 N.	Down.	V.N.	−·018811
	,, ,, 34	29·89	...	...	2·3 N.	Up.	V.N.	+·018811
	,, ,, 46	28·09	...	...	Away.	...	V.N.	.....
	,, 22 4	29·95	...	...	2·3 S.	Up.	V.N.	+·018811
	,, ,, 17	26·12	...	...	2·3 S.	Down.	V.N.	−·018811
	,, ,, 34	28·10	89·8	2·42	Away.	...	V.N.	.....
	,, ,, 50	25·00	...	...	2·0 S.	Down.	V.N.	−·029191
	,, 23 5	30·90	...	...	2·0 S.	Up.	V.N.	+·029191
	,, ,, 18	28·04	...	...	Away.	...	V.N.	.....
	,, ,, 35	30·85	...	...	2·0 N.	Up.	V.	+·029191
	,, ,, 52	25·01	...	...	2·0 N.	Down.	V.	−·029191
	15 0 6	28·02	90·0	2·43	Away.	...	V.	.....
	,, ,, 22	23·68	...	...	1·8 N.	Down.	V.	−·040842
	,, ,, 38	31·82	...	...	1·8 N.	Up.	V.	+·040842
	,, ,, 52	28·02	...	...	Away.	...	V.	.....
	,, 1 8	31·96	...	...	1·8 S.	Up.	V.	+·040842
	,, ,, 24	23·58	...	...	1·8 S.	Down.	V.	−·040842
	,, ,, 33	27·99	90·0	2·43	Away.	...	V.	.....
XV. 5th June 1882.	5 21 19	26·03	90·7	2·70	Away.	...	P.	.....
	,, ,, 32	25·18	...	...	3·0 N.	Down.	P.	−·008266
	,, ,, 45	26·82	...	...	3·0 N.	Up.	P.	+·008266
	,, ,, 58	26·03	...	...	Away.	...	P.	.....
	,, 22 12	26·82	...	...	3·0 S.	Up.	P.	+·008266
	,, ,, 25	25·20	...	...	3·0 S.	Down.	P.	−·008266
	,, ,, 38	26·02	90·8	2·70	Away.	...	P.	.....
	,, ,, 54	24·51	...	...	2·5 S.	Down.	P.	−·014510
	,, 23 11	27·48	...	...	2·5 S.	Up.	P.	+·014510
	,, ,, 24	26·05	...	...	Away.	...	P.	.....
	,, ,, 37	27·46	...	...	2·5 N.	Up.	P.	+·014510
	,, ,, 51	24·54	...	...	2·5 N.	Down.	P.	−·014510
	6 0 1	26·04	90·8	2·70	Away.	...	P.	.....
	,, ,, 15	24·11	...	...	2·3 N.	Down.	V.N.	−·018811
	,, ,, 30	27·80	...	...	2·3 N.	Up.	V.N.	+·018811
	,, ,, 42	26·02	...	...	Away.	...	V.N.	.....
	,, ,, 58	27·81	...	...	2·3 S.	Up.	V.N.	+·018811
	,, 1 16	24·10	...	...	2·3 S.	Down.	V.N.	−·018811
	,, ,, 28	26·00	90·9	2·70	Away.	...	V.N.	.....
	,, ,, 43	23·00	...	...	2·0 N.	Down.	V.N.	−·029191
	,, ,, 58	28·64	...	...	2·0 N.	Up.	V.N.	+·029191
	,, 2 11	26·00	...	...	Away.	...	V.N.	.....
	,, ,, 26	28·70	...	...	2·0 S.	Up.	V.	+·029191
	,, ,, 42	22·91	...	...	2·0 S.	Down.	V.	−·029191
	,, ,, 58	25·94	90·9	2·70	Away.	...	V.	.....
	,, 3 13	21·69	...	...	1·8 N.	Down.	V.	−·040842
	,, ,, 27	29·62	...	...	1·8 N.	Up.	V.	+·040842
	,, ,, 42	25·98	...	...	Away.	...	V.	.....
	,, ,, 56	29·72	...	...	1·8 S.	Up.	V.	+·040842
	,, 4 15	21·50	...	...	1·8 S.	Down.	V.	−·040842
	,, ,, 27	25·89	91·0	2·71	Away.	...	V.	.....
XVI. 3rd July 1882.†	3 21 3	30·10	91·2	1·39	Away.	...	P.	.....
	,, ,, 13	32·39	...	...	3·0 N.	Up.	P.	+·008438
	,, ,, 23	33·93	...	...	2·5 N.	Up.	P.	+·014700
	,, ,, 31	35·01	...	...	2·3 N.	Up.	P.	+·018970
	,, ,, 39	35·59	...	...	2·219 N.	Up.	P.	+·021114
	,, ,, 48	35·77	...	...	2·198 N.	Up.	P.	+·021801
	,, ,, 57	37·92	...	...	2·0 N.	Up.	P.	+·029149
	,, 22 7	40·04	...	...	1·890 N.	Up.	P.	+·033156
	,, ,, 16	42·19	...	...	1·820 N.	Up.	P.	+·039026
	,, ,, 25	43·09	...	...	1·8 N.	Up.	P.	+·040389
	,, ,, 34	45·30	...	...	1·768 N.	Up.	P.	+·042704
	,, ,, 42	46·51	...	...	1·750 N.	Up.	P.	+·044084
	,, ,, 55	31·11	91·3	1·39	Away.	...	P.	.....

* The readings were always taken twice over, as a check against any large error, and the number entered is the mean of the two readings.

† In these experiments and all later ones till the 6th June 1882, an interval of 10 minutes was allowed to elapse after the Vertical Force magnet became nearly still before the reading was taken. From the 3rd July 1882 the interval allowed was only 5 minutes.

TABLE 4—*continued.*

Number and date of experiment.	Local Time by Magnetograph Clock.	Vertical Force Magnetograph — Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.	Disturbing force (Y).
	d. h. m.							
XVIa								
3rd July 1882—*continued.*	3 23 8	32·59	...	...	3·0 S.	Up.	P.	+·008438
	,, ,, 20	34·09	...	...	2·5 S.	Up.	P.	+·014700
	,, ,, 30	35·11	...	...	2·3 S.	Up.	P.	+·018970
	,, ,, 38	35·69	...	...	2·219 S.	Up.	P.	+·021114
	,, ,, 46	35·90	...	...	2·198 S.	Up.	P.	+·021801
	,, ,, 57	38·05	...	...	2·0 S.	Up.	P.	+·029149
	4 0 6	40·09	...	...	1·890 S.	Up.	P.	+·033156
	,, ,, 13	42·27	...	...	1·820 S.	Up.	P.	+·039026
	,, ,, 21	43·21	...	...	1·80 S.	Up.	P.	+·040389
	,, ,, 30	45·70	...	...	1·768 S.	Up.	P.	+·042704
	,, ,, 40	46·50	...	...	1·750 S.	Up.	P.	+·044084
	,, ,, 51	31·40	90·8	1·39	Away.	...	P.	.....
	,, 1 9	28·48	90·8	1·41	3·0 S.	Down.	V.N.	—·008438
	,, ,, 23	26·02	...	...	2·5 S.	Down.	V.N.	—·014700
	,, ,, 36	22·82	...	...	2·3 S.	Down.	V.N.	—·018970
	,, ,, 53	29·87	91·0	1·42	Away.	...	V.N.	.....
	,, 2 4	27·50	...	...	3·0 N.	Down.	V.N.	—·008438
	,, ,, 13	25·00	...	...	2·5 N.	Down.	V.N.	—·014700
	,, ,, 25	21·11	...	...	2·3 N.	Down.	V.N.	—·018970
	,, ,, 43	29·72	91·1	1·43	Away.	...	V.N.	.....
XVIb								
5th July 1882.	5 18 2	34·35	91·2	1·51	Away.	...	P.	
	,, ,, 11	33·62	...	...	3·0 N.	Down.	P.	—·008438
	,, ,, 21	23·11	...	...	2·5 N.	Down.	P.	—·014700
	,, ,, 29	32·76	...	...	2·3 N.	Down.	P.	—·018970
	,, ,, 37	31·91	...	...	2·0 N.	Down.	P.	—·029149
	,, ,, 45	30·99	...	...	1·8 N.	Down.	P.	—·040389
	,, ,, 54	29·02	...	...	1·558 N.	Down.	P.	—·063404
	,, 19 2	28·00	...	...	1·477 N.	Down.	P.	—·075027
	,, ,, 10	27·02	...	...	1·416 N.	Down.	P.	—·085759
	,, ,, 19	25·01	...	...	1·323 N.	Down.	P.	—·106512
	,, ,, 29	22·92	...	...	1·256 N.	Down.	P.	—·125895
	,, ,, 39	21·05	...	...	1·209 N.	Down.	P.	—·142452
	,, ,, 54	19·04	...	...	1·169 N.	Down.	P.	—·158979
	,, 20 5	16·98	...	...	1·136 N.	Down.	P.	—·174626
	,, ,, 16	15·01	...	...	1·112 N.	Down.	P.	—·187370
	,, ,, 24	13·00	...	...	1·088 N.	Down.	P.	—·201396
	,, ,, 34	10·95	...	...	1·067 N.	Down.	P.	—·214892
	,, ,, 42	9·12	...	...	1·051 N.	Down.	P.	—·226011
	,, ,, 52	6·94	...	...	1·033 N.	Down.	P.	—·239486
	,, 21 0	5·04	...	...	1·020 N.	Down.	P.	—·249919
	,, ,, 8	2·99	...	...	1·007 N.	Down.	P.	—·260976
	,, ,, 16	0·99	...	...	0·994 N.	Down.	P.	—·272596
	,, ,, 30	33·87	91·2	1·51	Away.	...	P.	.....
	,, ,, 48	0·41	...	...	0·994 S.	Down.	P.	—·272596
	,, ,, 56	2·47	...	...	1·007 S.	Down.	P.	—·260976
	,, 22 5	4·30	...	...	1·020 S.	Down.	P.	—·249919
	,, ,, 13	5·99	...	...	1·033 S.	Down.	P.	—·239486
	,, ,, 21	8·32	...	...	1·051 S.	Down.	P.	—·226011
	,, ,, 29	10·02	...	...	1·067 S.	Down.	P.	—·214892
	,, ,, 36	12·02	...	...	1·088 S.	Down.	P.	—·201396
	,, ,, 44	14·09	...	...	1·112 S.	Down.	P.	—·187370
	,, ,, 52	15·83	...	...	1·136 S.	Down.	P.	—·174626
	,, 23 0	17·89	...	...	1·169 S.	Down.	P.	—·158979
	,, ,, 10	20·00	...	...	1·209 S.	Down.	P.	—·142452
	,, ,, 19	21·90	...	...	1·256 S.	Down.	P.	—·125895
	,, ,, 28	24·00	...	...	1·323 S.	Down.	P.	—·106512
	,, ,, 36	26·09	...	...	1·416 S.	Down.	P.	—·085759
	,, ,, 44	27·11	...	...	1·477 S.	Down.	P.	—·075027
	,, ,, 52	28·28	...	...	1·558 S.	Down.	P.	—·063404
	6 0 2	30·38	...	...	1·8 S.	Down.	P.	—·040389
XVIb								
5th July 1882—*continued.*	6 0 10	31·32	...	...	2·0 S.	Down.	P.	—·029149
	,, ,, 19	32·19	...	...	2·3 S.	Down.	P.	—·018970
	,, ,, 28	32·57	...	...	2·5 S.	Down.	P.	—·014700
	,, ,, 38	33·10	...	...	3·0 S.	Down.	P.	—·008438
	,, ,, 47	33·82	90·8	1·51	Away.	...	P.	.....
	,, 1 5	34·63	...	...	3·0 S.	Up.	V.N.	+·008438
	,, ,, 14	35·19	...	...	2·5 S.	Up.	V.N.	+·014700
	,, ,, 22	35·53	...	...	2·3 S.	Up.	V.N.	+·018970
	,, ,, 31	36·43	...	...	2·0 S.	Up.	V.N.	+·029149
	,, ,, 42	37·49	...	...	1·8 S.	Up.	V.N.	+·040389
	,, ,, 53	39·67	...	...	1·558 S.	Up.	V.N.	+·063404
	,, 2 3	40·88	...	...	1·477 S.	Up.	V.N.	+·075027
	,, ,, 13	42·00	...	...	1·416 S.	Up.	V.N.	+·085759
	,, ,, 24	44·32	...	...	1·323 S.	Up.	V.N.	+·106512
	,, ,, 35	46·70	...	...	1·256 S.	Up.	V.N.	+·125895
	,, ,, 46	48·88	...	...	1·209 S.	Up.	V.N.	+·142452
	,, 3 7	34·21	91·0	1·51	Away.	...	V.N.	.....
	,, ,, 24	48·26	...	...	1·209 N.	Up.	V.N.	+·142452
	,, ,, 35	46·38	...	...	1·256 N.	Up.	V.N.	+·125895
	,, ,, 46	44·23	...	...	1·323 N.	Up.	V.N.	+·106512
	,, ,, 55	42·10	...	...	1·416 N.	Up.	V.N.	+·085759
	,, 4 6	41·02	...	...	1·477 N.	Up.	V.N.	+·075027
	,, ,, 18	39·92	...	...	1·558 N.	Up.	V.N.	+·063404
	,, ,, 28	37·83	...	...	1·8 N.	Up.	V.N.	+·040389
	,, ,, 37	36·89	...	...	2·0 N.	Up.	V.N.	+·029149
	,, ,, 46	36·01	...	...	2·3 N.	Up.	V.N.	+·018970
	,, ,, 54	35·67	...	...	2·5 N.	Up.	N.N.	+·014700
	,, 5 2	35·11	...	...	3·0 N.	Up.	V.N.	+·008438
	,, ,, 11	34·43	90·9	1·51	Away.	...	V.N.	.....
XVIc								
14th July 1882.	14 19 57	33·29	89·9	2·28	Away.	...	P.	.....
	,, 20 8	35·25	...	...	3·0 N.	Up.	P.	+·008438
	,, ,, 18	36·71	...	...	2·5 N.	Up.	P.	+·014700
	,, ,, 28	37·80	...	...	2·3 N.	Up.	P.	+·018970
	,, ,, 36	38·36	...	...	2·219 N.	Up.	P.	+·021114
	,, ,, 44	38·56	...	...	2·198 N.	Up.	P.	+·021801
	,, ,, 54	40·80	...	...	2·0 N.	Up.	P.	+·029149
	,, 21 3	43·20	...	...	1·890 N.	Up.	P.	+·033156
	,, ,, 19	34·36	90·2	2·28	Away.	...	P.	.....
	,, ,, 43	43·90	...	...	1·89 S.	Up.	P.	+·033156
	,, ,, 53	44·58	...	...	2·0 S.	Up.	P.	+·029149
	,, 22 2	39·28	...	...	2·198 S.	Up.	P.	+·021801
	,, ,, 10	39·08	...	...	2·219 S.	Up.	P.	+·021114
	,, ,, 18	38·49	...	...	2·3 S.	Up.	P.	+·018970
	,, ,, 28	37·30	...	...	2·5 S.	Up.	P.	+·014700
	,, ,, 36	35·84	...	...	3·0 S.	Up.	P.	+·008438
	,, ,, 45	34·03	90·3	2·28	Away.	...	P.	.....
	,, ,, 58	31·82	...	...	3·0 S.	Down.	V.N.	—·008438
	,, 23 8	30·39	...	...	2·5 S.	Down.	V.N.	—·014700
	,, ,, 17	29·28	...	...	2·3 S.	Down.	V.N.	—·018970
	,, ,, 26	28·61	...	...	2·219 S.	Down.	V.N.	—·021114
	,, ,, 36	28·40	...	...	2·198 S.	Down.	V.N.	—·021801
	,, ,, 51	25·31	...	...	2·0 S.	Down.	V.N.	—·029149
	15 0 16	32·91	90·5	2·27	Away.	...	V.N.	.....
	,, ,, 34	25·35	...	...	2·0 N.	Down.	V.N.	—·029149
	,, ,, 46	27·79	...	...	2·198 N.	Down.	V.N.	—·021801
	,, ,, 59	27·91	...	...	2·219 N.	Down.	V.N.	—·021114
	,, 1 8	28·50	...	...	2·3 N.	Down.	V.N.	—·018970
	,, ,, 16	29·60	...	...	2·5 N.	Down.	V.N.	—·014700
	,, ,, 28	31·08	...	...	3·0 N.	Down.	V.N.	—·008438
	,, ,, 40	32·91	90·5	2·27	Away.	...	V.N.	.....

The data in tables 1, 2 and 3 will now be used to determine values of Y, and then those of table 4 to determine values of $\frac{dY}{ds}$, some of these being also applied to find values of *wo*, and thence the form of the curve of the knife-edge.

28. The first inquiry was as to the similarity of distribution of the magnetism of the vertical force magnet and of that of magnet N 3. In the following table are placed, side by side, deflections made by the same deflector magnet E 1—first on the magnet N3 (on July 1, 1876) and secondly on the vertical force magnet (on July 8, 1876): these are taken from Table 3 and, being multiplied by the respective values of a division of the scale (14′·29 and 14′·31) are converted into the comparable numbers shown in columns 4 and 5. The only distances which exactly correspond for the two sets of numbers are 1·2

and 1·4 feet; but the comparison has been extended by interpolation in column 4—for the distances 1·15, 1·25 and 1·3 by interpolating between those for 1·2 and 1·4, and for the distance 1·5 by interpolating between those for 1·4 and 1·6. The interpolation formula used was $d=\frac{D}{r^2\left(1-\frac{p}{r^2}\right)}$ where d is the double deflection, r the distance, and D and p constants.

TABLE 5.

Distance of deflector E 1. Feet.	Double deflections. Of Magnet N 3 on July 1, 1876. Scale-divisions.	Of the Vertical Force Magnet on July 8, 1876. Scale-divisions.	Of Magnet N 3 converted into minutes of arc.	Of the Vertical Force Magnet, converted into minutes of arc.	Excess of column 4 over column 5.
1	2	3	4	5	6
1·15	...	22·01	320′·1	320′·0	−0′·1
1·2	19·44	19·21	278′·9	279′·2	+0′·3
1·25	...	16·84	244′·6	244′·8	+0′·2
1·3	...	14·85	215′·8	215′·8	0′·0
1·4	11·89	11·73	170′·6	170′·6	0′·0
1·5	...	9·42	137′·0	136′·9	−0′·1
1·6	7·79	...	...	...	...

As these differences are within the range of the probable error of observation of the deflections, we conclude that it is safe to employ the magnet N 3 in lieu of the vertical force magnet for the experiments in question. And as the single set of deflections observed on the 9th February 1872 in the horizontal plane were made upon the Declination magnetograph in position—the arrangements for observing independently in the Electrometer Tower not having, at that time, been completed—we shall assume that the same holds with respect to the magnet of the Declination magnetograph, which is of the same size and form as the two other magnets.

29. The first step taken with the deflections in the horizontal plane was to calculate the constants D and p* in the expression for them $d=\frac{D}{r^2\left(1-\frac{p}{r^2}\right)}$ by an approximate application of the method of least squares. This was done separately for the deflections numbered I for two groups of VI to XI, for one group of XIII to XVI, and for XVI. The two groups of VI to XI were formed so as to include the greatest number of values of d for several different distances of which the least should be 1·8 foot, the corresponding values of Y being—as will be seen hereafter—those that are mainly influential in determing $\frac{dY}{ds}$: and the mean of the two values of p yielded by the two groups was adopted as applicable to all the experiments from II to XII. The data and results of these calculations are shown in tables 6 and 7 :—

* In dealing with deflections affected by large probable errors it would be misleading to take account of other constants than p in the full expression for the action of one magnet upon another,—or at least so long as the two magnets are not very near together.

TABLE 6.

Experiment.	Observed double deflection at distance (in feet) of						Deduced value of p.
	1·7	1·8	2·0	2·3	2·5	3·0	
I	13·71	...	8·29	...	4·21	2·425	+0·11566
VI	...	...	3·85	...	1·94	1·14	...
VII	...	...	3·79	...	1·93	1·11	...
VIII	...	...	3·85	...	1·98	1·21	...
IX	...	...	3·81	...	1·86	1·11	...
X	...	...	3·96	...	1·98	1·20	...
XI	...	...	3·78	...	1·89	1·10	...
VI to XI	...	...	3·84	...	1·93	1·14	+0·01294
VIII	...	5·36	3·85	...	1·98	1·21	Mean of these two = +0·02662
IX	...	5·34	3·81	...	1·86	1·11	
X	...	5·33	3·96	...	1·98	1·20	
XI	...	5·25	3·78	...	1·89	1·10	
VIII to XI	...	5·32	3·85	...	1·93	1·15	+0·04030
XIII	...	5·21	3·74	2·45	1·88	1·06	...
XIV	...	5·22	3·75	2·43	1·87	1·07	...
XV	...	5·18	3·75	2·44	1·85	1·01	...
XVI	...	5·19	3·79	2·42	1·90	1·06	...
XIII to XVI	...	5·20	3·76	2·43	1·87	1·05	+0·30800

TABLE 7.

Experiment XVI.					
Distance in feet.	Observed double deflection. — Sc. div.	Observed single deflection. — Converted into force.	Values of p and D.	Calculated single deflection. — in force.	Observed minus Calculated single deflection.
1	2	3	4	5	6
0·994	...	...	D (in force) = 0·44740	·27260	...
1·007	...	...		·26098	...
1·020	...	...		·24992	...
1·033	...	...		·23949	...
1·051	...	...		·22601	...
1·067	27·52	·21449		·21489	+ ·00040
1·088	25·46	·19843		·20140	+ ·00297
1·112	24·03	·18729		·18737	+ ·00008
1·136	22·51	·17544		·17463	− ·00081
1·169	20·48	·15962		·15898	− ·00064
1·209	18·28	·14247		·14245	− ·00002
1·256	16·21	·12634		·12589	− ·00045
1·323	13·67	·10654		·10651	− ·00003
1·416	11·04	·08605		·08576	− ·00029
1·477	9·65	·07521		·07503	− ·00018
1·558	8·16	·06360		·06340	− ·00020
1·8	5·19	·04045		·04039	− ·00006
2·0	3·79	·02954		·02915	− ·00039
2·3	2·42	·01886		·01897	+ ·00011
2·5	1·90	·01481		·01470	− ·00011
3·0	1·06	·00826	p = +·01628	·00844	+ ·00018

30. In experiment XVI the distances and deflections are extended as far as the limits of the scale of the instrument (from 0 to 28 divisions) will allow, partly for comparison with a similarly extended series of deflections of the vertical force magnetograph, and partly with a view to testing the accuracy of the law of variation of the deflections assumed in the formula* $d=\frac{D}{r^3\left(1-\frac{p}{r^3}\right)}$. The whole series of deflections at distances from 1·067 to 3·0 feet were first used to find p and D, and then the process was reversed, the formula being used to calculate values of d for each distance, and these values are entered in column 5 of Table 7. It will be seen by the differences in column 6 that—with the exception of that for the distance 1·088, which is evidently affected by some extraordinary error which a careful search has nevertheless failed to discover,—the formula accords well with the observations, the mean error scarcely exceeding a thousandth of the mean deflection. If all values of d for distances less than 1·7 foot had been excluded from the calculations, the agreement of the retained values would necessarily have been still closer, but on account of the smallness of the retained deflections, the probable error would have borne a larger proportion to the mean deflection, and the deduced p might have had a widely different value from the true one. For this reason it is unadvisable to calculate a value of p for each set of experiments, and better to apply a general value to a series of experiments: but on the other hand, it does not yet seem safe to assume that p remains unchanged for an unlimited time, and may be determined, once for all, from a set of large as well as small deflections, as in the example just dealt with. What has recently been decided upon for this Observatory is to observe one large deflection as part of each set of experiments of deflection in the horizontal plane, and when a series of such deflection observations has been accumulated, to determine p by combining in a suitable manner the mean large deflection with the aggregate of the means of the smaller deflections: it is expected that successive values of p obtained in this way will be in much better agreement with each other than are those of Table 6.

31. A rough estimate of the extent to which the law of our equation is followed by the mean deflections of Table 6, which have yielded the several values of p, may be obtained by multiplying the deflections by the respective values of r^3, when the products ought to vary in a gradual progression as r varies. The products are shown in Table 8:—

* When p is small in comparison with unity, this is practically the same as the theoretically more exact formula $d=\frac{D}{r^3}\left(1+\frac{p}{r^3}\right)$, and in the use that we make of it—as a smoothing agent merely—may safely be adopted, as is evidenced by the case under discussion, i.e. experiment XVI, in lieu of the latter. In future the exact formula will, however, be substituted for the merely approximate one.

TABLE 8.

Experiment.	Distance (r).					
	1·7	1·8	2·0	2·3	2·5	3·0
I	67·357	...	66·320	...	65·781	65·475
VI to XI	...	...	30·72	...	30·16	30·78
VIII to XI	...	31·03	30·80	...	30·16	31·05
XIII to XVI	...	30·326	30·080	29·566	29·219	28·350

The numbers in the first and last lines satisfy the required condition, but not those of either of the intermediate lines; hence as we may conclude from the experiment of Table 7 that the action of the deflector magnet upon the suspended magnet does in fact obey the law, we must attribute the apparent absence of it in the deflections of experiments VI to XI to some unrecognised extraneous influence or to error of observation: neither can any more satisfactory explanation at present be found of the large difference between the values of p given by the experiments XIII to XVI together and experiment XVI by itself, these being + 0·30800 and + 0·16284 respectively. Having already made the assumption that the distribution of the magnetism of the vertical force magnetograph magnet is the same as that of the magnet N3, the adoption of different values of p implies an assumption either that the distribution of the magnetism of the deflector magnet E1 has changed, or the more improbable one that the similarity in the two others is maintained by a similarity of change in them, or else that the means for finding p are imperfect, but being the best available the use of the values which they yield leads to less error than the use of any other values would. The last is the assumption on which we proceed, but it will presently be seen that much the greater part of any error involved in the use of an erroneous value of p is generally compensated by the introduction of an opposing error into the adopted value of the constant D. Practically it is only in the very few cases in which $\frac{dY}{ds}$ is determined from deflections of the vertical force magnetograph on one side only of the undisturbed position of the magnet, and not including that position, that an error in the adopted value of p will have its full effect, and that effect will be to make the coefficient too great or too small according as the adopted value of p is too great or too small, whether the deflections are on the side of increasing or decreasing scale-readings. In the only two cases of this kind that occur—those of experiments IIa and IIb—it will be seen, however, on inspection of the curve of Fig. 26 (to be presently described) that the two coefficients are not both in excess or both in defect of that which appears to be applicable to the intermediate part of the scale, and we may therefore regard any error of p, as affecting those cases, as unimportant. The effects of such an error on the value of $\frac{dY}{ds}$ for parts of the vertical force magnetograph scale far removed from the undisturbed reading would be considerable; but no values of $\frac{dY}{ds}$ have been determined under these conditions.

32. To enable a comparison to be made between the results obtained by the method that we have adopted for finding Y and those that would have been obtained if the simpler method had been adopted of equating Y, for each deflection distance, to the product of the angular deflection (corrected for torsion) multiplied by the horizontal force, we had intended to place along the curves of Figs. 24 to 44 (presently to be described) points representing the values of Y that are given by the simpler method; but finding that the points are generally so nearly coincident with the curves as to create confusion, we have instead placed the values of Y obtained by the two methods side by side in the following table:—

Table 9.

Experiment.	I.		II.		III.		IV.		V.		VI.		VII.		VIII.	
	Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.	
r.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.
1·2	...	...	·16918	·18101	·14313	·15591	...	...	·14083	·15126	...	...	...	...	...	...
1·4	...	...	...	...	...	...	...	...	·08824	·09252	...	...	...	...	...	...
1·5	...	...	·08604	·08922	·07279	·07584	...	...	...	...	·07162	·07396	·07121	·07329	...	...
1·6	...	...	...	...	...	...	...	...	·05893	·06061	...	...	...	...	...	...
1·7	·06025	·06034	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·8	...	...	...	...	...	...	·04197	·04312	·04129	·04163	...	...	...	...	·04106	·04184
2·0	·03658	·03648	·03611	·03620	·03055	·03037	·03055	·03115	·03006	·02996	·03006	·03000	·02988	·02964	·02988	·03005
2·4	...	...	...	...	...	...	·01764	·01761	·01736	·01751	...	...	...	...	·01726	·01725
2·5	·01853	·01853	...	...	...	...	...	...	...	...	·01535	·01512	·01526	·01509	·01526	·01546
3·0	·01066	·01067	·01066	·01059	·00902	·00845	...	...	...	...	·00887	·00888	·00882	·00868	·00882	·00945

Experiment.	IX.		X.		XI.		XII.		XIII.		XIV.		XV.		XVI.	
	Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.		Values of Y.	
r.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.	Taken from last column of Table 4.	Calculated from single deflections.
1·067	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·21489	·21449
1·088	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·20140	·19843
1·112	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·18737	·18729
1·136	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·17463	·17544
1·169	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·15898	·15962
1·209	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·14245	·14247
1·256	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·12589	·12634
1·323	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·10651	·10654
1·416	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·08576	·08605
1·477	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·07503	·07521
1·558	...	...	...	...	...	...	...	...	...	...	...	...	...	...	·06340	·06360
1·8	·04106	·04158	·04106	·04151	·04106	·04088	·04068	·04114	·04084	·04062	·04084	·04069	·04084	·04038	·04039	·04045
2·0	·02988	·02967	·02988	·03084	·02988	·02944	·02961	·03008	·02919	·02916	·02919	·02923	·02919	·02923	·02915	·02954
2·3	·01962	·01923	·01962	·01962	·01962	·01931	·01944	·01932	·01881	·01910	·01881	·01894	·01881	·01902	·01897	·01886
2·5	·01526	·01448	·01526	·01542	·01526	·01472	·01501	·01434	·01451	·01466	·01451	·01458	·01451	·01442	·01470	·01481
3·0	·00882	·00864	·00882	·00934	·00882	·00857	·00874	·00873	·00827	·00826	·00827	·00834	·00827	·00787	·00844	·00826

33. The deduced value of D for experiment I was 64·565. For II to XV a value of D was found, in each case, that should best accord with the adopted value of p and with the assumption that the probable errors of the several deflections—great or small—are about equal; and this was supposed to be obtained by dividing the sum of all the deflections for different distances by the sum of the values of $\frac{1}{r^3\left(1-\frac{p}{r^2}\right)}$ for the same distances—the weighting of the deflections being in this way proportional to their values. The results of these calculations are shown in Table 10.

TABLE 10.

Experiment.	$\Sigma\left\{\frac{2d}{r^3\left(1-\frac{p}{r^2}\right)}\right\}$	Value of $\Sigma\left\{\frac{2d}{r^3\left(1-\frac{p}{r^2}\right)}\right\}$	Means.
1	2	3	4
II.	$\frac{6\cdot01}{\cdot16209}$	36·873	
III.	$\frac{4\cdot96}{\cdot16299}$	30·431	31·020
IV.	$\frac{11\cdot74}{\cdot37140}$	31·610	
V.	$\frac{11\cdot45}{\cdot37140}$	30·829	30·660
VI.	$\frac{6\cdot93}{\cdot22727}$	30·492	
VII.	$\frac{6\cdot83}{\cdot22727}$	30·052	30·452
VIII.	$\frac{14\cdot61}{\cdot47283}$	30·899	
IX.	$\frac{14\cdot59}{\cdot48276}$	30·222	
X.	$\frac{14\cdot99}{\cdot48276}$	31·051	
XI.	$\frac{14\cdot50}{\cdot48276}$	30·036	
XII.	$\frac{14\cdot58}{\cdot48276}$	30·201	
XIII.	$\frac{14\cdot34}{\cdot51785}$	27·691	27·648
XIV.	$\frac{14\cdot34}{\cdot51785}$	27·691	
XV.	$\frac{14\cdot23}{\cdot51785}$	27·479	
XVI.	$\frac{14\cdot36}{\cdot51785}$	27·730	

34. The numbers in column 3 show a general decrease with time, which is doubtless due to the gradual loss of strength of the deflector magnet E1; but they are also subject to large casual variations of which no explanation can at present be offered except to surmise that—being of the same order—they are due to the same erratic influences that make the probable error of a determination of the absolute horizontal force so great as

a thousandth of the whole force. No reasonable estimate of the errors of the separate observational quantities that enter into a determination of the horizontal force would rate their effects nearly so highly, so that it is probable that some characteristic of the unifilar magnetometer is not yet fully understood, and it may be that due allowance for it would remove as large an absolute error from small deflection observations as from large ones. This surmisal, as to a possible direction in which to look for an explanation of the irregularities in question, is advanced only after most careful, but fruitless search for possible variations of condition of the deflection apparatus used, for errors in the adopted distances apart of the scale and the mirror attached to the suspended magnet, and for abnormal values of the horizontal force during the time occupied by a set of observations,—any of these that should be influential in any degree even approaching that of the irregularities. The torsion force of the suspension thread, though affecting the observed deflections, and allowed for in the next step of our procedure, is always too small to be of any account in this regard, and the same may be said of variations in the value of a division of the scale.

35. The precaution has always been taken to keep the deflector magnet E1, when not in use, well away from the influence of other magnets, but until the 13th May 1881 the magnet N3 was kept in a box, provided with the Colába set of magnetographs, between soft iron keepers and along with—though separated from—three other magnets belonging to the set of instruments. It is almost certain that the position and direction in its position of each magnet were always kept unaltered, but in June 1876, one of the magnets was removed bodily, and it might be conceived that this removal, by altering the position of the poles of the magnet N3, would alter the amounts of the observed deflections: this, however, would only affect the comparability of values of D for the time before with those for the time after June 1876, and would afford no explanation of irregularities occurring during either of the two periods. A supposition that the magnet N3 was, after use, placed indifferently with its north end pointing in one direction or the opposite relatively to the box, would possibly serve the latter purpose, but the supposition is too highly improbable to be admissible. From the 13th May 1881 the magnet N3 has, like E1, been kept isolated, *i.e.* at a distance from any other magnets.

36. A circumstance that should be mentioned is that the object glass of the observing telescope, which is very old, is a good deal weather-stained, so that in diffused daylight the image of the scale is seen somewhat indistinctly, whilst when the observations are taken after dark and the scale is illuminated artificially, the distinctness of the image is much improved. On this account all the experiments from April 16, 1880 (except that of January 11, 1881) have been made at night and with artificial light, and since this time there is an evident increase of consistency in successive values of D—that is, from experiment XI. onward.

37. It will be observed from Tables 1, 2 and 4 that the order of observation, with the deflector magnet in its different positions, has always been arranged so as to eliminate from the mean deflections the effect of any uniform change of declination occurring during the time of making a set of observations: but since the 8th February 1879 the elimination has been rendered a little more complete, by finishing a set of observations at a single distance before commencing a set at another distance, the time during which the assumption of uniformity of change is needed being thus generally reduced, and with advantage especially with respect to the deflections of smaller amount. In higher latitudes, where abrupt disturbances with abrupt reversals are common, the assumption would be quite inadmissible, but a careful examination of the declination magnetograph curves for the times of all the experiments has shown that no improvement worth consideration would be made upon the aggregate deflections (u) by correcting all the readings of each set of observations to a constant value of the declination: there were slight wavy disturbances on September 13, 1873, May 3, 1877 and June 6, 1882, but no significant changes and no departures from uniformity of movement worth mention even on any other of the occasions. The choice since the 16th April 1880, of night hours instead of day hours in which to make these experiments has an advantage—additional to that already spoken of, that the movement of the declination magnet under the influence of the regular diurnal variation of declination is at a slower rate at night than in the day; and for a similar reason the deflections of the vertical force magnetograph have also, since the 10th January 1881 been made at night, the slow rate of change in this case being in the regular diurnal variation of vertical force.

38. At an early stage of investigations of this nature the question of the degree of precision practically attainable presents itself for settlement; for, as it serves no useful purpose, and therefore involves needless labour, to determine some of the data of a problem with great accuracy whilst others have to be accepted with much larger probable errors, it depends upon this what amount of change from an adopted value need be regarded in any of the data made use of, and whether account need be taken of a number of influences that are known to form part of the conditions of the problem, but may be neglected if their effects are considerably smaller than the probable error of the final result. It will be seen later that the probable error of the finally adopted scale coefficients of the vertical force magnetograph is about a hundredth of the whole coefficient, and the limit within which extraneous affections and growth of data have been disregarded is one two hundredth ($\frac{1}{200}$th) of the whole.

39. The theory of these experiments does not require a knowledge of the strength, or magnetic moment, of the deflector magnet, but as a knowledge of this quantity would remove one source of doubt as to the cause of the irregularities in the values of D found in Table 10, the practice was introduced on the 18th August 1880 of using the magnet E1 to deflect the magnet N23c in the Unifilar magnetometer employed in the regular observations of horizontal force, at a distance of 1·0 foot, and in the usual four positions end-on to the middle of the deflected magnet,—such deflections being made as accessories to each set of experimental deflections in the horizontal plane. These auxiliary deflections, which will appear in a table further on, amount to nearly 7°, and they show that the loss of strength of the magnet E1 between the 18th August 1880 and the 15th July 1882, has been gradual and aggregates only about a hundredth of the total strength.

40. To return now to the consideration of the numbers in column 3 of Table 10, the irregularities in which are in the main still unexplained, it would seem that the best that can be done with them is to divide them into groups, the averages for which will exhibit the gradual decrease that necessarily results from the loss of strength of the deflector magnet, and to regard the averages as applicable to all the experiments under the respective groups: this has been done—the groups (or isolated experiments) being I, II, III and IV, V and VI, VII to XI, XII, and XIII to XV and the average values of D those entered in paragraph 33 and in column 4 of Table 10. A gradual change might have been allowed for in the case of the three years' group VII to XI, but in presence of the irregularities exhibited within that group, such an allowance would have been fairly characterised as over-refinement. Having now obtained the requisite data, the value of the disturbing force (Y) corresponding to each position of the deflector magnet in each of the experiments of deflection upon the vertical force magnetograph (those of Table 4) was calculated by the equation.

$$Y = Xa' \left(1 + \frac{H}{F}\right) \frac{D}{2r^3\left(1 - \frac{p}{r^2}\right)}$$

where a' is the angular value of a division of the scale on which the horizontal deflections are read off, $\left(1 + \frac{H}{F}\right)$ is the torsion coefficient of the suspension thread of the magnet N3, and $\frac{D}{2r^3\left(1 - \frac{p}{r^2}\right)}$ is the calculated single deflection. The values adopted of the several factors and of p in this expression are shown for each experiment in Table 11.

TABLE 11.

EXPERIMENT	X.	a' Minutes.	a' Arc / Radius.	$1 + \frac{H}{F}$	D.	p.	$\frac{Xa'\left(1+\frac{H}{F}\right)D.}{2}$
I.	3·7218	8′·13	·00236	Included in a'.	64·565	+0·11566	·28415
II.	3·7222	14′·36	·00418	1·0010	36·873	+0·02662	·28695
III AND IV.	3·7251	14′·365	·00418	1·0055	31·020	+0·02662	·24275
V AND VI.	3·7310	14′·290	·00416	1·0046	30·660	+0·02662	·23886
VII TO XI.	3·7361	14′·304	·00416	1·0033	30·452	+0·02662	·23748
XII.	3·7403	14′·30	·00416	1·0016	30·201	+0·02662	·23532
XIII TO XV.	3·7420	14′·30	·00416	1·0017	27·648	+0·30800	·21555
XVI.	3·7435	14′·30	·00416	1·0011	28·702	+0·16284	·22370

And the values of $\frac{1}{r^3\left(1 - \frac{p}{r^2}\right)}$ for each value of p and r are shown in Table 12.

TABLE 12.

r	p.			
	+0·11566.	+0·02662.	+0·30800.	+0·16284.
·994	.....	.....	.....	1·12186
1·007	.....	.....	.....	1·11666
1·020	.....	.....	.....	1·11172
1·033	.....	.....	.....	1·10706
1·051	.....	.....	.....	1·10103
1·067	.....	.....	.....	·96062
1·088	.....	.....	.....	·90028
1·112	.....	.....	.....	·83759
1·136	.....	.....	.....	·78062
1·169	.....	.....	.....	·71067
1·2	.....	·58960	.....	.....
1·209	.....	.....	.....	·63680
1·25	.....	·52087	.....	.....
1·256	.....	.....	.....	·56278
1·26	.....	·50843	.....	.....
1·3	.....	·46245	.....	.....
1·323	.....	.....	.....	·47613
1·35	.....	·41247	.....	.....
1·4	.....	·36945	.....	.....
1·416	.....	.....	.....	·38336
1·45	.....	·33222	.....	.....
1·477	.....	.....	.....	·33539
1·5	.....	·29984	.....	.....
1·558	.....	.....	.....	·28343
1·6	.....	·24671	.....	.....
1·7	·21202	·20543	.....	.....
1·75	.....	.....	.....	·19707
1·768	.....	.....	.....	·19090
1·8	·17782	·17289	·18948	·18055
1·82	.....	.....	.....	·17445
1·89	.....	.....	.....	·15520
1·9	·15062	·14688	.....	.....
2·0	·12872	·12583	·13543	·13030
2·1	·11089	.....	.....	.....
2·198	.....	.....	.....	·09745
2·2	·09621	·09443	.....	.....
2·219	.....	.....	.....	·09439
2·3	·08403	·08261	·08727	·08480
2·4	·07382	·07267	.....	.....
2·5	·06521	·06427	·06732	·06571
2·6	·05789	·05712	.....	.....
2·7	·05162	.....	.....	.....
2·8	·04624	·04571	.....	.....
2·9	·04157	.....	.....	.....
3·0	·03752	·03715	·03835	·03772

By multiplying the number of a particular experiment taken from the last column of Table 11 successively by the several numbers from Table 12 corresponding to the values of r and p for that experiment, we obtain the set of values of Y for that experiment: these are entered in the last column of Table 4.

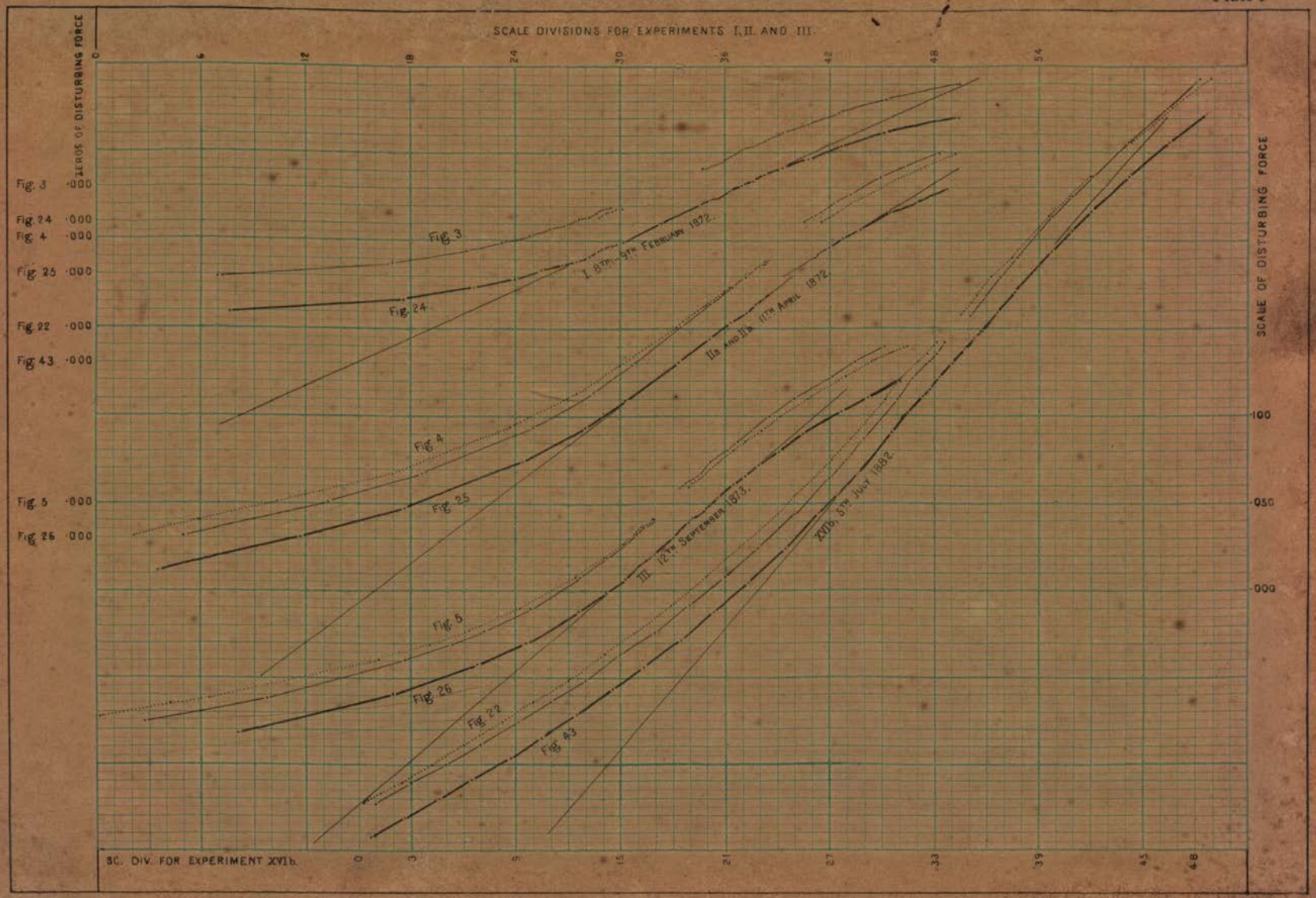
41. The next step in our procedure was to construct a curve, for each experiment, representing the variation of vertical force with variation of scale reading of the vertical force magnetograph, the numbers in columns 3 and 9 of Table 4 being taken as abscisse and ordinates respectively. Figs. 3 to 23 are copies of these curves, which we proceed to examine. The upper left hand branch of Fig. 3 is evidently displaced with reference to the three other branches: this arises from the observations which it represents having been taken on the following day, when a change had taken place in the position of the vertical force magnet. Similar displacements appear in the upper right hand branches of Figs. 4 and 5, but of these no satisfactory explanation presents itself.* In the first and last cases constant corrections (of +0·66 and +0·38 respectively) have, before proceeding further, been applied to bring the readings into general accord with those of the respective adjacent branches, the average readings for corresponding distances in the pairs of branches being thus made equal: in the second case the right and left hand branches are treated as if they belonged to independent experiments, the one yielding a value of

* See remark on a feature in the behaviour of the instrument in paragraph 59: it is this behaviour that wants explanation.

COLABA VERTICAL FORCE MAGNETOGRAPH.

SCALE—COEFFICIENTS.

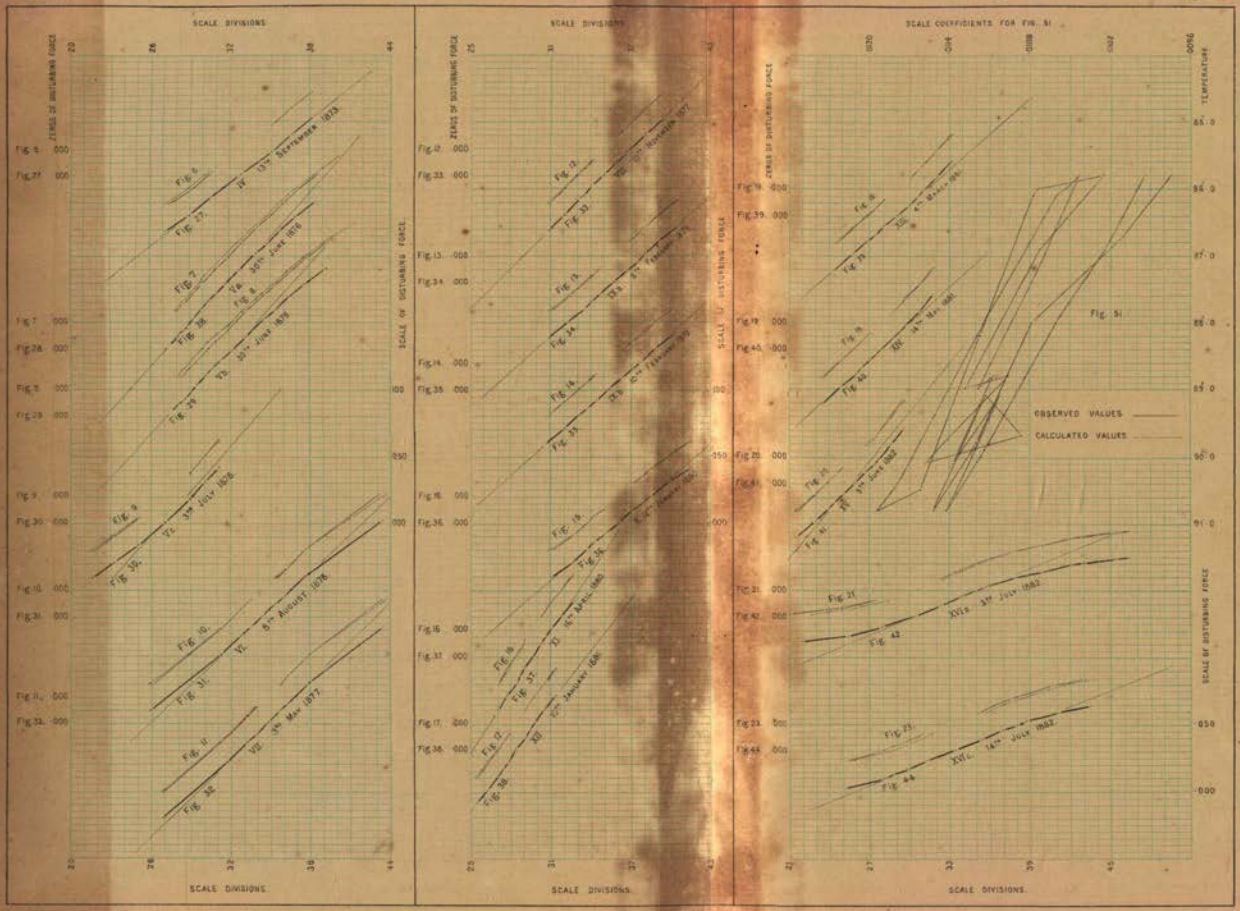
Plate I.



COLABA VERTICAL FORCE MAGNETOGRAPH.

SCALE COEFFICIENTS.

Plate II.



the scale coefficient corresponding to one scale-reading, and the other to another scale-reading. Mean scale-readings were now taken, for each experiment, and for corresponding distances, and new curves (Figs. 24 to 44) were constructed to represent them. The means are shown in Table 13.

TABLE 13.

r.	EXPERIMENT.																					
	I.	IIa.	IIb.	III.	IV.	Va.	Vb.	Vc.	VI.	VII.	VIII.	IXa.	IXb.	X.	XI.	XII.	XIII.	XIV.	XV.	XVIa.	XVIb.	XVIc.
·994	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·70	...
1·007	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2·73	...
1·020	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4·67	...
1·033	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6·46	...
1·051	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8·72	...
1·067	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10·48	...
1·088	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12·51	...
1·112	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14·55	...
1·136	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16·40	...
1·169	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18·46	...
1·2	...	3·59	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·209	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20·52	...
1·25	...	11·83	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·256	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22·41	...
1·3	...	17·82	...	8·14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·323	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24·50	...
1·4	...	24·40	...	16·99	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·416	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	26·55	...
1·477	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	27·55	...
1·5	...	27·96	...	21·78	...	...	...	...	26·02	26·98	...	...	...	...	...	...	...	...	...	...	...	...
1·558	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28·65	...
1·6	...	30·34	...	24·59	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·8	7·69	33·36	...	27·61	27·34	...	...	21·64	...	...	30·97	31·05	30·83	31·16	27·12	25·48	24·47	23·63	21·59	...	30·68	...
1·9	17·64	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·0	21·77	35·17	...	29·26	28·97	...	...	23·40	31·35	31·85	32·15	32·46	32·15	32·70	27·89	26·36	25·92	25·00	22·95	...	31·61	25·33
2·1	24·01	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·198	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28·09
2·2	25·54	36·37	...	30·27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·219	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28·26
2·3	26·69	...	...	...	...	...	...	...	...	...	33·65	33·35	33·95	28·61	27·13	27·04	26·12	24·10	21·96	32·47	28·89	
2·4	27·54	37·20	...	30·93	30·69	...	...	25·14	...	...	33·42	...	...	...	...	...	...	...	...	...	...	...
2·5	28·26	...	...	...	...	...	...	...	32·92	33·33	33·61	34·14	33·88	34·41	28·85	27·50	27·52	26·54	24·52	25·51	32·84	29·99
2·6	28·80	37·78	...	31·39	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·7	29·22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·8	29·58	38·23	...	31·75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·9	29·87	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3·0	30·11	38·53	...	31·98	...	...	...	...	33·62	33·96	34·25	34·89	34·55	35·30	29·23	28·01	28·25	27·21	25·19	27·99	33·36	31·45
∞	32·41	39·89	39·89	33·01	32·84	27·35	27·46	27·24	34·56	34·87	35·08	35·76	35·47	36·16	29·90	28·57	29·16	28·07	26·00	30·61	34·10	33·56
3·0	34·81	...	41·13	33·95	...	28·11	28·25	...	35·46	35·79	36·00	36·83	36·53	37·21	30·42	29·27	30·07	28·91	26·82	32·49	34·87	35·54
2·9	35·03	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·8	35·29	...	41·49	34·20	...	28·30	28·49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·7	35·61	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·6	35·97	...	42·01	34·60	...	28·56	28·70	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·5	36·45	...	...	...	...	...	...	...	36·15	36·44	36·68	37·56	37·23	37·98	30·89	29·64	30·67	29·51	27·47	34·01	35·43	37·00
2·4	36·99	...	42·78	35·03	35·10	28·90	29·08	29·00	...	...	36·88	...	...	...	...	...	...	...	...	...	...	...
2·3	37·62	...	...	...	...	...	...	...	...	...	...	38·02	37·75	38·57	31·21	29·90	31·11	29·92	27·80	35·06	35·77	38·14
2·219	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35·64	...	38·72
2·2	38·45	...	43·83	35·61	...	29·37	29·56	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·198	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	35·83	...	38·92
2·1	39·44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2·0	40·77	...	45·58	36·48	36·70	30·05	30·26	30·20	37·80	38·03	38·20	39·26	38·94	40·06	31·95	30·69	32·15	30·87	28·67	37·98	36·66	41·19
1·9	42·60	...	46·96	37·19	...	30·50	30·75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·89	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	40·06	...	43·55
1·82	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	42·23	...	...
1·8	45·27	...	48·72	38·03	38·23	31·09	31·40	31·24	...	...	39·49	40·65	40·44	41·72	32·77	31·53	33·27	31·89	29·67	43·15	37·66	...
1·768	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	45·50	...	...
1·75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46·50	...	...
1·7	49·53	...	...	39·08	...	31·81	32·27	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·6	...	...	...	40·54	...	32·77	33·26	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·558	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39·79	...
1·5	...	...	...	42·75	...	34·05	34·65	...	43·57	43·68	...	...	...	...	...	...	...	...	...	...	...	...
1·477	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	40·95	...
1·45	...	...	...	44·19	...	34·84	35·49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·416	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	42·05	...
1·4	...	...	...	46·07	...	35·82	36·53	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·35	...	...	...	...	...	37·00	37·78	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·323	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	44·27	...
1·3	...	...	...	...	...	38·48	39·40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1·256	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	46·54	...
1·209	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	48·57	...

42. As many points as possible, including generally the point of no disturbance, were now selected, by inspection of each curve, as would fulfil the condition of lying all nearly in the same straight line, and for which the several scale-coefficients would therefore be nearly uniform: the mean scale-reading and disturbing force corresponding to each point then afforded an equation of the form

$$o\,(s-S)=Y. \qquad (9)$$

and those corresponding to all the points selected from a given curve a set of such equations from which to determine by the method of least squares, the values for the part of

that curve included between the extreme points, of o or $\frac{dY}{ds}$ and S or the scale-reading for which $Y=o$. The values of o and S, for the several experiments, are shown in Table 14, and they are represented also by the straight lines drawn on Figs. 24 to 44, by means of which the agreement of the line and points of each of the several curves may be estimated. Strong lines are marked in Table 13 in the positions corresponding to the limits of the selected points.

TABLE 14.

Date.	Experiment.	S.	o or $\frac{dY}{ds}$.	Scale-reading of Points.		V. F. Thermometer.	V. F. Vacuum gauge.	Value of m.
				Least.	Greatest.			
1	2	3	4	5	6	7	8	9
8—9th February 1872 ...	I.	32·42	·004589	28·80	37·62	89·1	...	·680
11th April 1872	IIa.	39·96	·007523	33·36	38·53	90·2	1·63	·678
11th April 1872	IIb.	39·37	·006137	41·13	42·78	90·2	1·63	·678
12th September 1873 ...	III.	32·96	·008550	29·96	36·48	89·3	2·45	·662
13th September 1873 ...	IV.	32·86	·007926	28·97	36·70	88·1	2·50	·662
30th June 1876	Va.	27·32	·011008	27·35	31·09	93·5	3·43	·634
30th June 1876	Vb.	27·45	·010696	27·46	30·26	93·8	3·43	·634
3rd July 1876	Vc.	...	...	27·24	31·24	92·5	3·45	·633
8th August 1876	VI.	34·56	·009427	31·35	37·80	91·0	2·36	·632
3rd May 1877	VII.	34·90	·009726	31·85	38·03	91·3	2·42	·624
10th November 1877 ...	VIII.	35·14	·009893	30·97	38·20	92·5	2·47	·618
8th February 1879 ...	IXa.	35·83	·008773	31·05	39·26	87·6	2·65	·605
10th February 1879 ...	IXb.	35·53	·008844	30·83	37·75	88·0	2·67	·605
12th January 1880	X.	36·22	·008548	32·70	38·57	84·5	2·90	·595
16th April 1880	XI.	29·87	·015004	27·12	31·21	88·9	1·52	·592
10th January 1881	XII.	28·55	·013297	25·48	31·53	85·8	1·76	·584
4th March 1881	XIII.	29·06	·008810	24·47	33·27	86·7	2·40	·582
14th May 1881	XIV.	27·97	·009130	23·63	31·89	89·8	2·42	·581
5th June 1882	XV.	...	...	21·59	29·67	90·8	2·70	·569
3rd July 1882	XVIa.	30·52	·004139	30·61	35·83	91·0	1·40	·568
5th July 1882	XVIb.	34·11	·011546	31·61	34·87	91·0	1·51	·568
14th July 1882	XVIc.	33·50	·004068	28·09	38·92	90·3	2·28	·568

43. Considering now Figs. 24 to 26 and 43, the curves of which have a long range, by themselves, we see at a glance that the middle parts are much more inclined to the axis of abscissæ than the two ends, and the change of inclination is gradual both to the right and to the left, though it is so small as to be scarcely perceptible through a considerable part of the middle of the scale: this implies that the scale-coefficient is a maximum in the middle part and grows smaller towards each end of the scale. Indeed on the 3rd July 1882, when the instrument was adjusted for greater sensibility, but yet so as to leave the scale-coefficient for the division 33·2 about ·004, it became an oversetting balance when the scale-reading was either less than 21 or greater than 49. Observing also that the straight lines of Figs. 24, 26 and 43 and the lower one of Fig. 25 are, as nearly as the eye can detect, tangents to the parts of the curves which are most inclined to the axis of abscissæ, and therefore represent the maximum scale-coefficients of the respective curves, we may, as we shall presently show, regard the corresponding coefficients as applicable, without material error, to any part of the scale between 32 and 36 divisions, and therefore to the division 33·2; the latter division we have chosen—as being nearly midway between 32 and 36, but otherwise arbitrarily,—to be referred to as the scale-reading that will be found when the knife-edge of the vertical force magnet rests on its part of minimum curvature. The middle points of the parts of the curves to which the coefficients actually apply correspond to the scale-readings 33·21, 35·94, 32·87 and 33·24—all within the limits laid down.

44. Attributing the change of sensitiveness of the instrument with change of scale-reading to the varying curvature of the knife-edge of the magnet, we are now prepared to apply the equation (5a) to find how much force, tending to increase any change of position from the scale-reading 33·2, the magnet exerts in each of the positions taken up by it in the four sets of deflection experiments:—

Equation (5a) is $\frac{Wg}{m}(wo) = \left(X+\frac{Wg}{m}c\sin\epsilon\right)as - Y - (C-Y_1)$

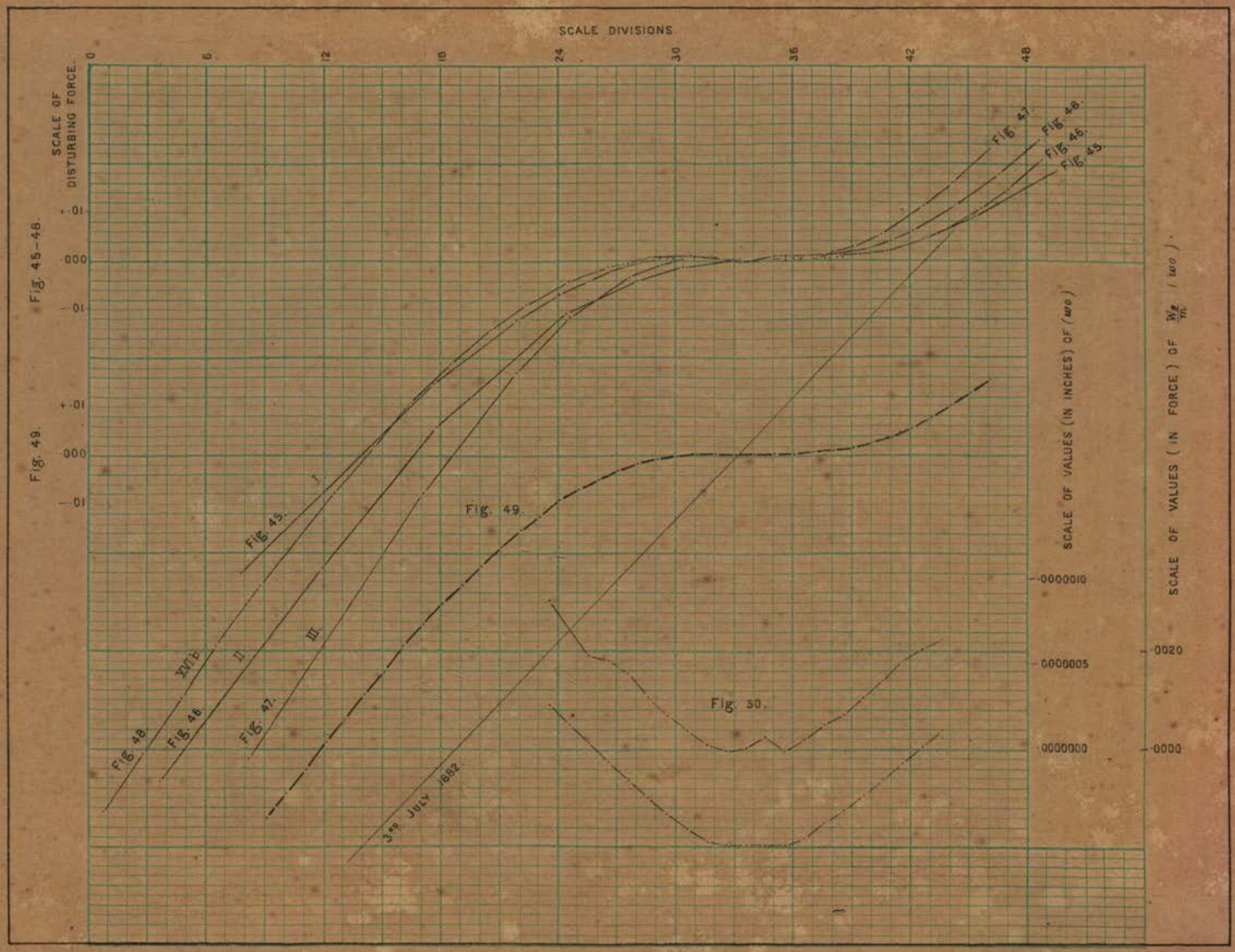
$$= \left(X+\frac{Wg}{m}c\sin\epsilon\right)a(s-S) + \left(X+\frac{Wg}{m}c\sin\epsilon\right)aS - \left(X+\frac{Wg}{m}c\sin\epsilon\right)a\times 33{\cdot}2 - Y + Y_1$$

$$= \left\{\left(X+\frac{Wg}{m}c\sin\epsilon\right)a(s-S) - Y\right\} + \left(X+\frac{Wg}{m}c\sin\epsilon\right)a(S-33{\cdot}2) + Y_1 \qquad (9a)$$

COLABA VERTICAL FORCE MAGNETOGRAPH.

CURVATURE OF KNIFE-EDGE.

Plate III.



in which, if we assume that the last two terms are together equal to *zero*, we shall be neglecting the, at present unknown, small values of $\frac{Wg}{m}(wo)$ that accumulates between the scale-readings s and 33·2; but as this small quantity will be a constant affection of all the values of $\frac{Wg}{m}(wo)$, and as we shall practically have to deal only with differences between different values, the constant will disappear in the differences and it may therefore be altogether disregarded. We thus obtain:—

$$\frac{Wg}{m}(wo) = (X + \frac{Wg}{m} c \sin \epsilon)\, a\,(s - S) - Y. \qquad (9b)$$

For insertion in this equation the mean scale-readings (s) are obtained from Table 13, the values of S and the approximate values of $(X + \frac{Wg}{m} c \sin \epsilon)\, a$* from Table 14, columns 3 and 4 respectively, and the disturbing forces (Y) from the last column of Table 4. Premising that the value of W having been 1760·1 grains until the 13th January 1880 and 1802·6 grains since the 20th January 1880, the results obtained from the first three of the four sets of experiments have been multiplied by 1·0241 $\left(=\frac{1802{\cdot}6}{1760{\cdot}1}\right)$ to render them, so far, comparable with those of the last set, the values found for $\frac{Wg}{m}(wo)$ are shown in Table 15. By an oversight a corresponding reduction of the four sets of results to a constant value of m was omitted at this stage, but the effect of the omission will presently be allowed for.

TABLE 15.

EXPERIMENT I.		EXPERIMENT II.		EXPERIMENT III.		EXPERIMENT XVIb.	
V. F. Magneth. Scale-reading.	$\frac{Wg}{m}(wo)$.	V. F. Magneth. Scale-reading.	$\frac{Wg}{m}(wo)$.	V. F. Magneth. Scale-reading.	$\frac{Wg}{m}(wo)$.	V. F. Magneth. Scale-reading.	$\frac{Wg}{m}(wo)$.
7·69	−·0645	3·59	−·1069	8·14	−·1024	0·70	−·1132
17·64	−·0256	11·83	−·0637	16·99	−·0480	2·73	−·1013
21·77	−·0126	17·82	−·0347	21·78	−·0234	4·67	−·0900
24·01	−·0073	24·40	−·0113	24·59	−·0120	6·46	−·0798
25·54	−·0043	27·96	−·0043	27·61	−·0039	8·72	−·0671
26·69	−·0025	30·34	−·0016	29·26	−·0011	10·48	−·0579
27·54	−·0015	33·36	·0000	30·27	−·0001	12·51	−·0480
28·26	−·0006	35·17	+·0001	30·93	+·0003	14·55	−·0385
28·80	−·0002	36·37	+·0001	31·39	+·0005	16·40	−·0299
29·22	·0000	37·20	+·0001	31·75	+·0008	18·46	−·0217
29·58	+·0001	37·78	·0000	31·98	+·0007	20·52	−·0145
29·87	+·0001	38·23	+·0001	33·95	−·0006	22·41	−·0092
30·11	+·0001	38·53	−·0001	34·20	−·0005	24·50	−·0044
34·81	+·0003	41·13†	+·0021	34·60	+·0002	26·55	−·0016
35·03	+·0002	41·49	+·0024	35·03	+·0001	27·55	−·0008
35·29	·0000	42·01	+·0030	35·61	−·0003	28·65	+·0003
35·61	·0000	42·78	+·0044	36·48	−·0005	30·68	+·0008
35·97	−·0002	43·83	+·0061	37·19	+·0005	31·61	+·0003
36·45	·0000	45·58	+·0103	38·03	+·0014	32·47	·0000
36·99	·0000	46·96	+·0148	39·08	+·0025	32·84	·0000
37·62	·0000	48·72	+·0207	40·54	+·0050	33·36	−·0002
38·45	+·0003			42·75	+·0112	34·87	+·0003
39·44	+·0007			44·19	+·0157	35·43	+·0005
40·77	+·0018			46·07	+·0229	35·77	+·0002
42·60	+·0041					36·66	+·0003
45·27	+·0086					37·66	+·0006
49·53	+·0187					39·79	+·0022
						40·95	+·0039
						42·05	+·0059
						44·27	+·0108
						46·54	+·0176
						48·57	+·0245

† The values of S for the numbers respectively above and below this mark are 39·96 and 39·44. *See* footnote to paragraph 44.

45. Figs. 45 to 48 have been constructed to represent these numbers, the abscissæ of the curves being scale-readings and the ordinates values of $\frac{Wg}{m}(wo)$.† Remarking on these that in their principal features they tell the same tale,

* The upper right hand branch of Fig. 4 is shifted bodily, with reference to the line of continuity of the rest of the curve, to the left: the average displacement of it is 1·05 Sc. div. and the zero reading adopted for comparison with the means of the two right hand branches is, accordingly, 0·52 Sc. div. less than that adopted for the two left hand branches; that is, the value of S for experiment II*a* being 39·96, that for experiment II*b* is 39·44; and the two partial experiments being thus brought into connection with each other the coefficient (·007523) found for experiment II*a* is applied to the complete experiment II.

† Only the numbers of experiment XVI*b* are curved near the divisions 32 to 36, where otherwise confusion would arise from the nearness to co-incidence of the four curves.

and passing by—for the moment—the discrepancies exhibited amongst them, we proceed to find an average set of values of $\frac{Wg}{m}(wo)$ and to construct an average curve. The first step taken was to combine points lying between one scale-reading and the next by simple averaging, thus reducing the number of points on each curve to not more than one between each pair of adjacent scale-readings: the next step was to interpolate between every successive pair of points remaining on a curve the values of $\frac{Wg}{m}(wo)$ for all the integral scale-readings lying between the respective pairs of points, on the assumption of a uniform rate of change of $\frac{Wg}{m}(wo)$ between each pair of points,—in this way obtaining an ordinate for each curve corresponding to each integral scale-reading: the third step was to average the four values of $\frac{Wg}{m}(wo)$ for the four experiments: and the fourth and last step was to construct the average curve (Fig. 49) representing these values. Afterwards the differences were taken between the averages for the scale-readings 23 and 24, 24 and 25,..... and 43 and 44, these differences representing the additional scale-coefficient of the instrument, due to varying curvature of the knife-edge of the magnet, for every part of the scale that has come into use in the course of the instrument's action as a recorder of variations of the vertical magnetic force. The averages and differences are shown in Table 16:—

TABLE 16.

Scale Reading	Average value of $\frac{Wg}{m}(wo)$. $W=1802{\cdot}6$ $m=0{\cdot}643$	Difference.	Values of (wo).	Values of $\frac{\Delta(wo)}{\Delta s}$	Smoothed values of $\frac{\Delta(wo)}{\Delta s}$	Values of $\frac{Wg}{m}(wo)$ $W=1760{\cdot}1$ $m=0{\cdot}678$	$W=1760{\cdot}1$ $m=0{\cdot}643$	$W=1802{\cdot}6$ $m=0{\cdot}577$
1	2	3	4	4a	4b	5	6	7
			Inch.	Inch.				
9	−·0745[a]	...	−·00002154	.....	.....	−·0690	−·0727	−·0830
10	−·0694	...	−·00002006	.....	.....	−·0643	−·0678	−·0773
11	−·0643	..	−·00001859	.....	.....	−·0595	−·0628	−·0717
12	−·0593	...	−·00001713	.....	.....	−·0549	−·0579	−·0661
13	−·0543	...	−·00001571	.....	.....	−·0503	−·0530	−·0605
14	−·0495	...	−·00001430	.....	.....	−·0458	−·0483	−·0552
15	−·0446	...	−·00001288	.....	.....	−·0413	−·0435	−·0497
16	−·0397	...	−·00001147	.....	.....	−·0368	−·0388	−·0442
17	−·0349	...	−·00001009	.....	.....	−·0323	−·0341	−·0390
18	−·0307	...	−·00000887	.....	.....	−·0284	−·0300	−·0342
19	−·0268	...	−·00000775	.....	.....	−·0248	−·0262	−·0299
20	−·0230	...	−·00000664	.....	.....	−·0213	−·0225	−·0256
21	−·0192	...	−·00000555	.....	.....	−·0178	−·0187	−·0214
22	−·0158	...	−·00000456	.....	.....	−·0146	−·0154	−·0176
23	−·0127	+·0030	−·00000366	+·00000086	+·00000082	−·0118	−·0124	−·0142
24	−·0097	+·0025	−·00000280	+·00000071	+·00000071	−·0090	−·0095	−·0108
25	−·0072	+·0019	−·00000209	+·00000055	+·00000060	−·0067	−·0070	−·0080
26	−·0053	+·0017	−·00000154	+·00000051	+·00000049	−·0049	−·0052	−·0059
27	−·0036	+·0015	−·00000103	+·00000043	+·00000038	−·0033	−·0035	−·0040
28	−·0021	+·0010	−·00000060	+·00000029	+·00000028	−·0019	−·0021	−·0023
29	−·0011	+·0007	−·00000031	+·00000018	+·00000018	−·0010	−·0011	−·0012
30	−·0004	+·0003	−·00000013	+·00000010	+·00000010	−·0004	−·0004	−·0004
31	−·0001	+·0001	−·00000003	+·00000002	+·00000002	−·0001	−·0001	−·0001
32	·0000	−·0001	−·00000001	−·00000001	·00000000	·0000	·0000	·0000
33	−·0001	·0000	−·00000002	·00000000	·00000000	−·0001	−·0001	−·0001
34	−·0001	+·0002	−·00000002	+·00000006	·00000000	−·0001	−·0001	−·0001
35	+·0001	−·0001	+·00000004	−·00000003	·00000000	+·0001	+·0001	+·0001
36	·0000	+·0002	+·00000001	+·00000004	+·00000004	·0000	·0000	·0000
37	+·0002	+·0004	+·00000005	+·00000012	+·00000012	+·0002	+·0002	+·0002
38	+·0006	+·0007	+·00000017	+·00000019	+·00000020	+·0006	+·0006	+·0007
39	+·0013	+·0010	+·00000036	+·00000029	+·00000029	+·0012	+·0013	+·0015
40	+·0023	+·0013	+·00000065	+·00000039	+·00000038	+·0021	+·0022	+·0026
41	+·0036	+·0018	+·00000104	+·00000051	+·00000048	+·0033	+·0035	+·0040
42	+·0054	+·0020	+·00000155	+·00000058	+·00000058	+·0050	+·0053	+·0060
43	+·0074	+·0022	+·00000213	+·00000064	+·00000068	+·0069	+·0072	+·0082
44	+·0096		+·00000277			+·0089	+·0094	+·0107
45	+·0122		+·00000354			+·0113	+·0119	+·0134
46	+·0152		+·00000439			+·0141	+·0148	+·0169

a From these numbers the last two decimals have been cut off since the calculation from them of the values of (wo) in Col. 4

The differences are curved in Fig. 50 on a scale ten times more open, as regards the ordinates, than that of Fig. 49; and a line is drawn, with a free hand, to represent the general course of the curve,* which is seen to be of a very definite character, and far too extensive to allow of the characteristic of the instrument which it exposes being ignored in any attempt at even approximately accurate interpretation of the records. A second scale of ordinates, representing the values of $\frac{\Delta(wo)}{\Delta s}$ given in column 4*a* of the table, is attached to Fig. 50, and from the free-hand curve of Fig. 50 the smoothed values of $\frac{\Delta(wo)}{\Delta s}$ are read off, with the same scale, and entered in column 4*b*: the meaning of these numbers will presently appear.

46. The justification of our assumption (paragraph 25) that the scale-coefficient is a maximum and practically uniform between the scale-readings 32 and 36 is to be found in the horizontality of both the curves (Figs. 49 and 50) in that region.

47. If the four curves of Figs. 45 to 48 had been more exact counterparts of each other, it might have been worth while to devise a more exact mode of interpolation, but the process adopted is as elaborate as the nature of the materials operated upon would justify. One reason why the curves differ is that they have not been reduced to a constant value of m, and the average curve must be understood to represent values of $\frac{Wg}{m}(wo)$ in in which $\frac{1}{m}$ is the average of its separate values at the times of the four experiments. The vertical force magnet was used to deflect the magnet N 23*e* in the Kew Unifilar Magnetometer on the 20th December 1871 and again on the 14th January 1880, being placed at a distance of 1·0 foot and directed end-on to the suspended magnet: the angles of deflection found were 9° 43′ 10″ and 8° 25′ 55″ respectively, and half the sine of the angle (·0844 or ·0733) multiplied by the horizontal force (8·0735 or 8·1128 British units) gives the magnetic moment (m) of the vertical force magnet (in British units) nearly enough for the present purpose: the respective products are 0·681 and 0·595, and, assuming that the diminution of m has been throughout at a uniform rate, we find for its values at the times of the four experiments† 0·680, 0·678, 0·662 and 0·568, whence the m of the average curve is 0·643. Using this value of m, 1802·6 as that of W, 32·108 as that of g and 0·46108 as the divisor for converting mm—mg-s units into British units, we have divided the average values of $\frac{Wg}{m}(wo)$ by $\frac{\cdot 46108}{12}\frac{Wg}{m}$, and have thus obtained a set of values of (wo) expressed in inches. These are given in column 4 of Table 16.

48. We have seen (paragraph 5) that these numbers may, under certain conditions, be regarded as invariable: hence we have only to multiply them by the particular value of $\frac{0\cdot 46108}{12}\frac{Wg}{m}$, corresponding to the time of a particular experiment, to obtain the several values of $\frac{Wg}{m}(wo)$ (in mm—$m.g.$—s units) to be allowed for in that experiment. Thus to find the value of the coefficient, from any experiment, for the scale-division 33·2, that experiment furnishes us with a series of equations of the form [that of (5*a*) with transposition]

$$\left(X+\frac{Wg}{m}\,c\,\sin\epsilon\right)\ as = Y+\frac{Wg}{m}(wo)+(C-Y) \qquad (10)$$

in which s and $Y+\frac{Wg}{m}(wo)$ are known, and $\left(X+\frac{Wg}{m}\,c\,\sin\epsilon\right)a$ and $(C-Y)$ may be found by least squares. This is the method that we propose to adopt in future, but with the restriction that only such equations are to be included in a series as have values of s that lie between 23 and 44: it has been applied also to the experiment XV (of June 5, 1882) and retrospectively to experiment V*c* (of July 3, 1876) with the respective results $\left(X+\frac{Wg}{m}\,c\,\sin\epsilon\right)a = \cdot 01233$ and $\cdot 01110$, and $(C-Y) = \cdot 32042$ and $\cdot 30238$; and it is with these data that the straight lines on Figs. 41 and 30 have, as exceptional cases, been constructed.

* In the printed copy of the curves, the free-hand line has, to avoid confusion, been constructed below the other.

† These and the values of m for the times of the remaining experiments are entered in column 9 of Table 14.

49. It is unnecessary, however, to incur so much labour with respect to the rest of the experiments: for I. to V*b* and VI to XI of these it will suffice to keep us within our standard limits of error to use the equation (7*a*) in the form

$$(X+\frac{Wg}{m}c\sin\epsilon)a=\frac{dY}{ds}+\frac{\Delta\left\{\frac{Wg}{m}(wo)\right\}}{\Delta s} \quad . \qquad (11)$$

taking $\frac{dY}{ds}$ from the 4th column of Table 14 and Δs as the increase from the least to the greatest of the scale readings shown in columns 5 and 6 of the same table, and $\Delta\left\{\frac{Wg}{m}(wo)\right\}$ as the corresponding increase of the numbers in column 6 of Table 16. These last numbers are obtained from those in column 4 by multiplying the latter by $\frac{0{\cdot}46108}{12}\frac{Wg}{m}$ for the case in which W=1760·1, g=32·108 (foot-second units), and m=0·643: and other sets of values of $\frac{Wg}{m}(wo)$ obtained in the same manner with other values of W and m, are—for convenience—entered in columns 5 and 7 of the table. One general value (0·643) of m has been adopted as exact enough for all the experiments I and III to XII, their own proper value (0·678) for II*a* and II*b*, and the general value 0·577 for XIII to XVI*c*: for I to XI the value of W was 1760·1 and for XII to XVI*c* it was 1802·6. Table 17 exhibits the data and results of equation (11) for all the experiments to which it was applied:—

TABLE 17.

Experiment (date).	$\frac{dY}{ds}$	Δs.	$\Delta\left\{\frac{Wg}{m}(wo)\right\}$	$\frac{\Delta\left\{\frac{Wg}{m}(wo)\right\}}{\Delta s}$.	$(X+\frac{Wg}{m}c\sin\epsilon)a$	V. F. Thermometer.
1	2	3	4	5	6	7
I (8—9th February 1872) ..	·004589	8·82	·0016	·000181	·00477	89·1
II*a* (11th April 1872) ...	·007523	5·17	·0010	·000183	·00771	90·2
II*b* (11th April 1872) ...	·006137	1·65	·0031	·001782	·00792	90·2
III (12th September 1873)...	·008550	7·22	·0008	·000110	·00866	89·3
IV (13th September 1873)...	·007926	7·73	·0010	·000129	·00805	88·1
V*a* (30th June 1876) ...	·011008	3·74	·0031	·000802	·01181	93·5
V*b* (30th June 1876) ...	·010692	2·80	·0023	·000821	·01151	93·8
V*c* (3rd July 1876) ...	.....	...	.....	.....	·01110	92·5
VI (8th August 1876) ...	·009427	6·45	·0004	·000062	·00949	91·0
VII (3rd May 1877)... ...	·009726	6·18	·0006	·000097	·00982	91·3
VIII (10th November 1877)...	·009893	7·23	·0008	·000111	·01000	92·5
IX*a* (8th February 1879) ...	·008773	8·21	·0016	·000195	·00897	87·6
IX*b* (10th February 1879) ...	·008844	6·92	·0004	·000058	·00890	88·0
X (12th January 1880) ...	·008548	5·87	·0010	·000170	·00872	84·5
XI (16th April 1880) ...	·015004	4·09	·0034	·000831	·01583	88·9
XII (10th January 1881) ...	·013297	6·05	·0063	·001041	·01434	85·8
XIII (4th March 1881) ...	·008810	8·80	·0094	·001068	·00988	86·7
XIV (14th May 1881) ...	·009130	8·26	·0120	·001452	·01058	89·8
XV (5th June 1882) ...	.....	...	.....	.....	·01233	90·8
XVI*a* (3rd July 1882) ...	·004139	5·22	·0002	·000038	·00418	91·0
XVI*b* (5th July 1882) ...	·011546	3·26	·0002	·000061	·01161	91·0
XVI*c* (14th July 1882) ...	·004068	10·83	·0035	·000323	·00439	90·3

50. We are now prepared to understand a graphical illustration that Fig. 49 may be made to afford of the change of sensitiveness of the instrument with change of scale-reading and of its ultimately oversetting when a particular division is reached either on the side of increasing or decreasing readings. On the figure and passing through the scale-division 33·2 we have drawn a straight line to represent the coefficient $(X+\frac{Wg}{m}c\sin\epsilon)a$ for the time of the experiment of July 3, 1882, so that equation (7*a*)

$$\frac{dY}{ds}=(X+\frac{Wg}{m}c\sin\epsilon)a-\frac{Wg}{m}\frac{d(wo)}{ds}$$

is represented in its first term of the second side by the tangent to the angle which the straight line makes with the axis of abscissæ, and in its second term by the tangent to the angle which a tangent line to the curve at a particular point makes with the axis of abscissæ; and consequently, the last term being affected with the negative sign, if the inclination of the tangent line at a given point be greater than that of the drawn straight

line the value of $\frac{dY}{ds}$, the actual scale-coefficient for that point, will be negative, that is the instrument will be unstable and the magnet will overset. If we imagine a tangent line drawn parallel to the drawn straight line it will touch the curve near the division 18 on the lower part and near the division 50* (perhaps) on the imagined prolongation of the higher part, whilst between these two scale-readings the tangent lines will have a smaller inclination than the drawn straight line, and beyond them in both directions they will have a greater inclination. Hence the state of the instrument will be one of stability between the specified scale-readings and one of instability beyond them.

A similar illustration, but necessarily confined to the stable part of the scale, is afforded by Figs. 24 to 26 and 43, the curves of which all tend, at their extremities, towards horizontality, the direction which implies a *zero* coefficient and that the instrument is in a state of neutral equilibrium.

51. We shall see further on that such a disturbance of the vertical force magnet as takes place when a set of deflection experiments is made upon it constitutes a break in the continuity of its registrations,—the magnet stopping short, on the withdrawal of the disturbing force, of its original undisturbed position. For this reason it is undesirable that deflection experiments should be made too frequently, but on the other hand the scale coefficient is subject—even after allowance for the effect of change of position of the magnet—to such considerable variations, of which the accepted theory of the instrument takes no account, that it is unsafe to assume that it changes at a uniform rate for any lengthened period. Choosing the lesser of two evils, we have, therefore, since the 16th August 1880 had deflection experiments on a small scale made once every month, whilst still continuing the more complete experiments once a year or oftener. The same deflector magnet (E 1) was used in the monthly experiments as in the others, but it was placed at a constant distance on the north side of the instrument only, and one reading only was taken for each of the positions of the deflector—north end down—and north end up†: the constant distance was 1·8 foot from April 16, 1880, to January 10, 1881, and 2·3 feet from January 17, 1881, to June 5, 1882. The readings and differences (or double deflections) are shown in Table 18, as are also the single deflections—with the deflector at 1·0 foot distance—referred to in paragraph 39:—

TABLE 18.

Date.	Distance in feet.	Lesser scale-reading.	Greater scale-reading.	Double deflection.	$\Delta\left\{\frac{Wg}{m}(\infty)\right\}$	2F+Col. 6.	$\frac{\left(X+\frac{Wg}{m}\sin\epsilon\right)a}{\text{Col. 7}+\text{Col. 5.}}$	Thermometer of V.F. Magnet $\frac{h}{t}$	Time reckoned in months from T_0, $\frac{}{T}$	Single deflections of Magnet N 22c by Magnet E1 at 1·0 foot distance.
1	2	3	4	5	6	7	8	9	10	11
16th April 1880 ...	1·8	27·15	32·72	5·57	·0033	·0850	·01527	88·9	3·5	...
16th August 1880 ...	1·8	26·22	31·99	5·77	·0051	·0868	·01505	88·7	7·5	6 55
17th August 1880 ...	1·8	26·26	32·19	5·93	·0047	·0864	·01457	89·2	7·5	
17th September 1880.	1·8	26·04	31·98	5·94	·0053	·0870	·01465	87·9	8·6	6 56
15th October 1880 ...	1·8	26·14	31·86	5·72	·0051	·0868	·01518	88·3	9·5	6 55
19th November 1880.	1·8	26·05	31·94	5·89	·0053	·0870	·01477	87·2	10·6	6 55
18th December 1880.	1·8	26·10	32·18	6·08	·0051	·0868	·01428	85·9	11·6	6 55
7th January 1881 ...	1·8	25·90	32·04	6·14	·0055	·0872	·01420	85·5	12·2	6 55
10th January 1881 ...	1·8	25·57	31·49	5·92	·0059	·0876	·01480	85·8	12·3	6 55
17th January 1881 ..	2·3	22·98	28·11	5·13	.....	.....	.....	85·6	...	6 55
20th February 1881 ..	2·3	27·09	31·30	4·21	·0034	·0410	·00974	85·8	0·0	6 55
4th March 1881 ...	2·3	27·01	31·09	4·08	·0036	·0412	·01010	86·7	0·4	6 55
21st April 1881 ...	2·3	26·45	30·31	3·86	·0040	·0416	·01078	88·0	2·0	6 54
14th May 1881 ...	2·3	26·12	29·89	3·77	·0046	·0422	·01119	89·8	2·8	6 54
16th June 1881 ...	2·3	25·82	29·54	3·72	·0052	·0428	·01151	90·8	3·9	6 53
16th July 1881 ...	2·3	25·63	29·50	3·87	·0054	·0430	·01111	89·1	4·9	6 54
25th August 1881 ...	2·3	25·29	29·29	4·00	·0058	·0434	·01085	89·7	6·2	6 54
17th September 1881.	2·3	25·29	29·02	3·73	·0056	·0432	·01158	90·1	7·0	6 54
19th October 1881 ...	2·3	24·89	28·89	4·00	·0062	·0438	·01095	88·8	8·0	6 54
16th November 1881.	2·3	24·73	28·65	3·92	·0066	·0442	·01127	89·0	9·0	6 54
15th December 1881 .	2·3	24·39	28·55	4·16	·0070	·0446	·01072	86·9	9·9	6 54
17th January 1882 ...	2·3	23·93	28·42	4·49	·0084	·0460	·01024	85·8	11·0	6 53
15th February 1882.	2·3	23·83	28·10	4·27	·0082	·0458	·01073	86·0	12·0	6 53
16th March 1882 ...	2·3	23·62	27·93	4·31	·0088	·0464	·01077	86·5	13·0	6 53
19th April 1882 ...	2·3	24·01	28·06	4·05	·0076	·0452	·01116	88·2	14·1	6 53
16th May 1882 ...	2·3	24·06	27·92	3·86	·0072	·0448	·01161	90·5	15·0	6 52
5th June 1882 ...	2·3	24·01	27·75	3·74	·0070	·0446	·01192	90·8	15·7	6 52

* If the curve of Fig. 48 had been constructed to suit the value of m as it was on July 3, 1882,—that is for $m = ·568$ instead of $m = ·643$,—these unstable equilibrium readings would have been both nearer the middle of the scale, as are the actual positions of instability noted in paragraph 43.

† Once in every six months two complete sets of deflections are made at the single distance.

52. The numbers in column 6, which correspond to those in columns 3 and 4, were taken from column 2 of Table 16. They should have been obtained from column 7 of that table, but as the mistake will not affect our final results by more than the probable error of any one of them, it is not worth while to repeat the tedious calculations which follow.

53. Table 18 contains two series of comparable deflections—the one dating from April 16, 1880, to January 10, 1881, and the other from February 20, 1881, to June 5, 1882. Premising that the changes of horizontal force were inconsiderable, the auxiliary deflections in column 11 tell us that, during both periods, the strength of the deflector magnet (E 1) also was practically constant: hence we decide to use as the constant disturbing force (Y) of the first period, at distance 1·8 foot, the mean (·0409) of the two values adopted for April 16, 1880, and January 10, 1881, in Table 4, and of the second period, at distance 2·3 foot, the value adopted (·0188) in the same table for March 4 and May 14, 1881, and for June 5, 1882. The doubles of these numbers (·0817 and ·0376) are the values of $2Y$ used in calculating the numbers in column 7 of Table 18.

54. On curving the numbers in column 8 as abscissæ, with the numbers in column 9 as ordinates, it was at once seen that the variations of the two were of simultaneous increase and decrease and were almost completely represented by to and fro motions along a straight line: from this we infer that an increase of temperature of the vertical force magnetograph decreases the sensitiveness of the instrument.

55. Observing also from Table 17 that the scale coefficients of the period April 1872 to July 1876 show a large increase with lapse of time, we formed—for trial—the hypothesis that the coefficient varies conjointly as the time (T) and as the temperature (t), so as to be expressible in the form—

$$\text{Coefficient} = A + b\,(t - 80) + c\,T \qquad (12)$$

Applying the hypothesis first to the second period of Table 18, the numbers in columns 8, 9 and 10 furnish data for seventeen equations of the form of (12), and these equations, being combined by the method of least squares, give values of the constants as follows: $A = +\cdot00844$; $b = +\cdot000{,}258$; and $c = +\cdot000{,}044{,}6$. On now inserting these values in equation (12), and calculating the values of the coefficients for the temperatures and times of the several experiments, they were found to agree fairly with the numbers in column 8, the probable error of one of which came out as $\pm\cdot00011$ or about one hundredth of the whole coefficient. Fig. 51 exhibits both the observed and calculated values of the coefficients.

56. As the horizontal force is independent of the temperature of the magnetograph, we must—in the full expression, $(X + \frac{Wg}{m}\,a\sin\epsilon)\,a$, for the coefficient*—attribute any observed effect of temperature to the term $\frac{Wg}{m}\,a\,(c\sin\epsilon)$, and in this—since the factor $\frac{Wg}{m}\,a$ was practically constant during the period—to the factor $c\sin\epsilon$; in other words, we must attribute it to a depression of the centre of gravity of the magnet and its attachments with relation to the height of the knife-edge. The amount of the depression—*per* degree of temperature—will be $\frac{\cdot000{,}258}{\frac{Wg}{m}\,a}$ millimetres if $\frac{Wg}{m}$ be expressed in *mm—m.g.—s* units, or $\frac{\cdot000{,}258}{\cdot46108}\,\frac{m}{Wga}$ feet if $\frac{Wg}{m}$ be expressed in British units: hence—inserting numerical values

$$\frac{\Delta\,(c\sin\epsilon)}{\Delta\,t} = \cdot000{,}258 \times \frac{12}{\cdot46108} \times \frac{0{\cdot}576}{1802{\cdot}6 \times 32{\cdot}108 \times \cdot00154} = \cdot000{,}043{,}39 \text{ inch} \qquad (13)$$

57. As soon as the suspicion is suggested, it seems not improbable that although the line of the knife-edge passes nearly through the centre of figure of the magnet, yet—as the centre of the mirror and the brass frame in which the mirror is clamped are sensibly lower—there may, when the whole mass is heated, be a very minute balance of downward expansion of the mass over upward expansion—a balance which will be exaggerated if the rate of expansion of the agate wedge per unit of length is less than that of its brass socket and attachments. It will be seen too, when we come to consider the heating

* Equation (11).

experiments that—in like manner—other conditions far outweigh change of strength of the magnet in producing a change of scale-reading when the instrument is bodily heated; and that the evidence afforded by the experiments—though of a mixed kind, and therefore inconclusive—is, as far as it goes, favourable to the hypothesis of an increase of temperature causing a decrease of the sensitiveness of the instrument. But no mere expansion under the influence of heat could possibly displace the centre of gravity so much, for each degree, as is required by equation (13); and the only suggestion of a possibly adequate influence that occurs to us is that the flexure of the two ends of the magnet under the action of gravity is increased by increase of the temperature of the magnet; but on the subject of molecular changes of the magnet more will be said further on. The simplest test of the hypothesis itself would, however, be to make a set of deflections of the vertical force magnetograph at a relatively low temperature, and then to heat the room and repeat the experiments at a high temperature; and when a fitting time* arrives, this will be done. Meanwhile, the scientific course is to adopt the hypothesis—which rests on *some* evidence—till a better is established: and as the second period of Table 18, which involves two progressions from low to high temperatures and one intermediate progression from high to low, is—of those that are available—the only suitable one for yielding a value of the temperature variation of the scale-coefficient, we shall adopt that value (·000258) for all the other periods also. It is true that the attachments of the magnet were altered near the beginning of the years 1880 and 1881, but the alterations were in lateral appendages that were designed to expand effectively only in the horizontal direction, and with no means of guessing what residual effect they may have, it must be assumed to be *nil*. The legitimacy of the assumption may, however, be tested by observing whether the scale-coefficients of other periods agree better amongst each other after or before they are corrected for temperature; and correction, it will be seen, increases the regularity of the numbers.

58. It has been long known that in the damp warm atmosphere of Bombay the sensitiveness of the vertical force magnetometer is subject to rapid diminution, owing to the formation of organic matter, which constitutes a sort of connecting spring between the knife-edge and the agate plane; but it was expected that when the atmosphere surrounding the instrument was kept dry and in a highly attenuated condition, as it has been now for more than ten years past,† this phenomenon would disappear: the mischief attending it has undoubtedly been greatly mitigated, but signs of organic action—in the shape of irregular ramifying lines on the faces of the agate prism and plane and of a general weather staining—are still noticeable in a more or less pronounced form according as the interval since the last cleaning of the agates is greater or less; and it is to this action that we suppose the increase of the scale-coefficient with simple lapse of time to be mainly due. It may be mentioned that in the cleaning process—(1) the agate faces and edge are rubbed with a linen cloth moistened with a mixture of prepared chalk and alcohol, (2) the chalk is removed by linen cloths, (3) the rubbing is repeated, with a clean linen cloth and alcohol alone several times, and (4) the surfaces and edge are brushed with the rough edge of a fresh torn piece of clean white paper, the last operation being to remove any fluff remaining from the linen cloths; finally, everything is carefully inspected with a strong magnifying glass.

59. It would not, however, be going altogether out of the field of experience to suggest that a sensible part of the observed diminution of sensitiveness of the vertical force magnetograph may possibly be due to molecular changes in the mass of the magnet and its attachments; in other words, to a secular yielding of the molecular force of cohesion to the stress of gravity acting at the centres of gravity of the two ends of the magnet. That molecular actions far exceed the minimum force that the instrument has the power of distinctly recording, we have evidence of several kinds: (1) If the instrument be made very sensitive (with the scale-coefficient at all approaching ·005), it is practically impossible—even using the greatest care—to prevent the occasional occurrence of a jump, or sudden dislocation, in the curve; the least shock on replacing the lamp, even although resting on woollen pads, is sufficient to jerk the molecules of the magnet into a new set that appears

*That is, when the concerted observations of the International Polar Commission have come to an end.

†The maximum pressure of the air in the enclosure during this period was 3·45 inches of mercury, or less than an eighth of a full atmosphere, and the maximum annual rate of leakage 0·43 inch. Between April 14, 1872, and July 7, 1876, the fall of the vacuum gauge was from 1·62 to 1·83 inches; between July 14, 1876, and January 14, 1880, from 2·32 to 2·90 inches; between January 24, 1880, and January 16, 1881, from 1·51 to 1·76 inches; between February 1, 1881, and June 27, 1882, from 2·40 to 2·73 inches; and on July 17, 1882, it was left at 2·26 inches. Before April 1872 the air in the enclosure was under the natural pressure of the atmosphere.

to be permanent: (2) When the instrument is first adjusted, after being subjected to the rough handling that the pulling and pushing of its balancing weights constitutes, the ordinates of the curves yielded by it go on continuously changing in one direction for many days together, and so largely that they are all but valueless as records of the relatively minute magnetic forces that are thus buried in what must be regarded as traces of the effects of re-arrangement of molecular strains in the magnet and fittings. As an example of such change may be mentioned a fall of scale-reading of nearly seven divisions—equivalent to a force of nearly a tenth of a unit—between the 21st and 27th January 1880, a third of which occurred in a single day; this was after a fresh adjustment for temperature compensation had been made: (3) Similar but less extensive changes occur after gentler handling of the magnet: (4) When the vertical force magnetograph is deflected, by bringing the deflector magnet nearer and nearer gradually so as not to set the deflected magnet vibrating, it is found that the deflection grows larger for some minutes after the deflector has been left at rest; and on withdrawing the deflector—in the same manner—the vertical force magnet does not return fully to its former undisturbed position, but stops at a point which—providing the disturbance has much exceeded the regular diurnal excursions of the magnet—is more distant from the original position in proportion (nearly) to the extent of the disturbance: both the growth of the deflection and the deviation from the original undisturbed position of the magnet are greater as the sensitiveness of the instrument is greater; and yet in both cases the vertical force magnet will, when otherwise at rest, respond to a minute disturbing force, or additional force, tending either to increase or decrease the scale-reading by ·01 division even (or ·00004 of force), showing that it is no obstruction akin to friction that prevents the full effect from being produced at once in the first case or at all in the second. Hence, it is difficult to find an explanation of this behaviour unless it be that change of position alters the molecular condition of the magnet—as by drawing its molecules towards the descending end, that a sensible time is required in which to effect the alteration, and that new arrangements of the molecules formed in the course of this alteration are not completely reversed on the reversal of the change of position of the magnet, and less completely the greater the disturbance has been. Figs. 52 to 56, which are copies of vertical force magnetograms obtained whilst deflection experiments were in progress, are intended to illustrate the behaviour of the instrument just spoken of.

60. It may be remarked that if the view here taken be correct, the instrument may be a much more exact indicator of small than of large variations of vertical force; for it is probable that the frequent reversal of the motion of the magnet within the range of its ordinary daily oscillations, will ultimately have disposed of all those re-arrangements of the molecules that are not completely reversed on the reversal of the motions, whilst such of these as are brought about only when large, and therefore infrequent, motions take place are a perpetual source of breaches of continuity in the purely magnetic record.

61. In the facts under discussion we find abundant reason for regarding the vertical force magnetograph, as Dr. Balfour Stewart tells us that it was intended to be regarded*, merely as a differential instrument, and for not following a former practice of this Observatory, of calculating an *absolute force* equivalent of every hourly position of the differential instrument: the addition of a large number like the absolute vertical force to the hourly inequalities of (say) a day's variations of the vertical force tends to obscure the smaller numbers that represent the significant phenomenon—the variation, and when repeated for a month of days, there is danger of overlooking the fact that the variation from hour to hour has a much less probable error than the variation from day to day. Moreover, the inevitable occasional alteration of the added constant that the practice involves, implies that errors comparable with the magnitude of the alterations, affect the values of the absolute vertical force that are attributed to different parts of a period for which a nearly constant addition is made.

62. Facts may here be mentioned which show how cautiously, under the extreme nicety of adjustment of the vertical force magnetograph, presumptions should be admitted that such and such disturbing influences will have no sensible effect upon the records of the instrument. There are two small brass screws attached to the magnet with their axes respectively vertical and horizontal, the one intended, by a movement of it, to alter the sensitiveness of the instrument, and the other to alter the position in respect of deviation

* Report of the British Association for the Advancement of Science, 1859, page 223.

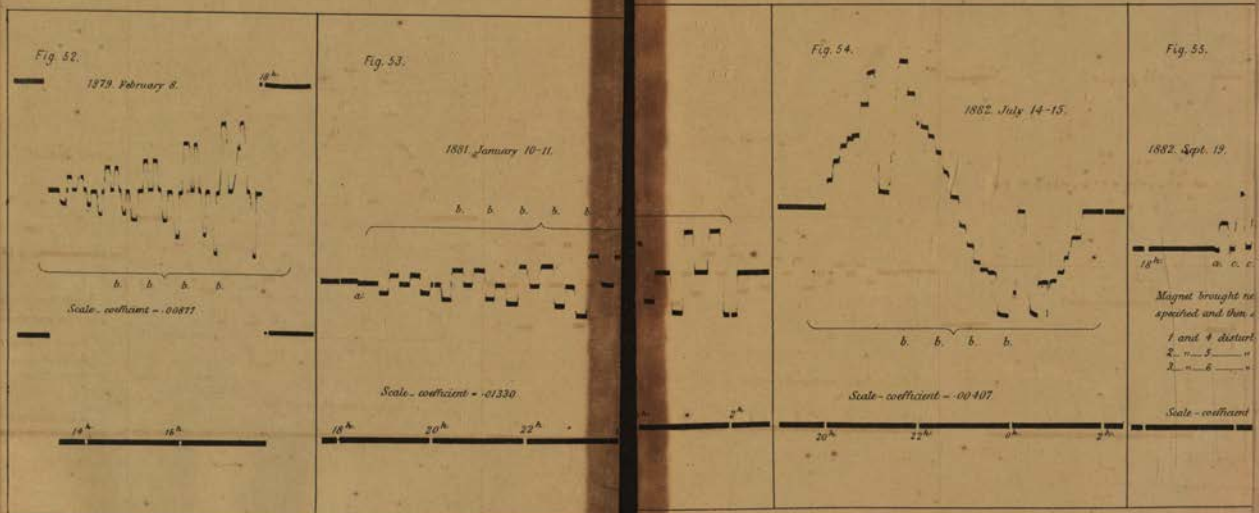
Copies of vertical force magnetograms illustrating var *ous features in the behaviour of the Colaba instrument.*

(a.) *In the appearance of dislocations in the curve wh* *the instrument is subjected to a slight jerk such as occurs at times on the replacement of the lam*

(b.) *In that when gently and slowly deflected the magnet tak* *as a sensible time in which to acquire its full departure from the undisturbed position, and simil*
not quite reaching the original position.

(c.) *In that the greater the deflection has been the greater is* *the falling short of a full return, whether the deflection be in a positive or negative direction; and*

(d.) *In that free oscillation of the magnet assists it towar* *gaining its full deflection or making a full return, but does not enable it completely to atta*
the greater the oscillation and the oftener it is rep *ated.*



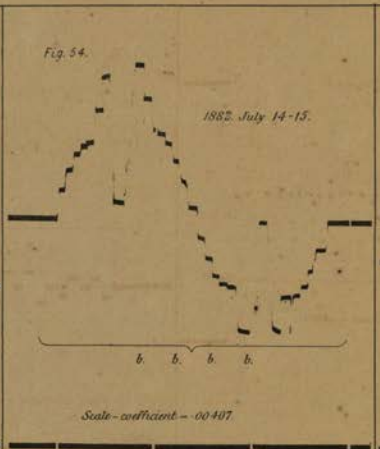
Lithographed, Govt Photozincc. Office Poona 1883.

...ous features in the behaviour of the Colaba instrument.

... the instrument is subjected to a slight jerk such as occurs at times on the replacement of the lamp,
...es a sensible time in which to acquire its full departure from the undisturbed position, and similarly on its return takes time to regain a position

... the falling short of a full return, whether the deflection be in a positive or negative direction; and
... gaining its full deflection or making a full return, but does not enable it completely to attain its goal, though the approach seems to be nearer
...ained.

Plate IV.



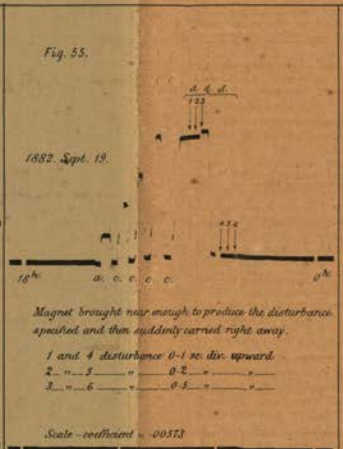


Fig. 55.
1882. Sept. 19.
d. d. d.
16h.
a. c. c. c. c.
0h.
Magnet brought near enough to produce the disturbance specified and then suddenly carried right away.
1 and 4 disturbance 0·1 sc. div. upward.
2 " 5 " 0·2 " "
3 " 6 " 0·5 " "
Scale-coefficient = ·00513

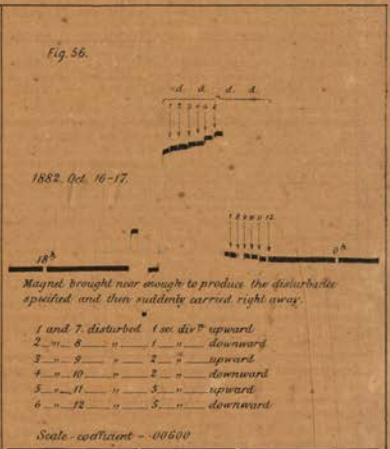


Fig. 56.
1882. Oct. 16-17.
d. d. d. d.
18h.
0h.
Magnet brought near enough to produce the disturbance specified and then suddenly carried right away.
1 and 7 disturbed 1 sc. div.n upward.
2 " 8 " 1 " downward
3 " 9 " 2 " upward.
4 " 10 " 2 " downward
5 " 11 " 5 " upward.
6 " 12 " 5 " downward.
Scale-coefficient = ·00600

from horizontality; but although to all appearance perfect and properly placed, the screws are either so unsymmetrical or their axes are so untrue that a partial turn of the vertical screw affects the balance considerably and a partial turn of the horizontal screw affects the scale-coefficient sensibly, and a required position and degree of sensitiveness can both be secured only by successive approximations.

63. Having now considered the coefficients b and c of equation (12) we proceed to consider the constant A. We may, in the first place, state that the deflection ring, and therefore the arms, which are rigidly attached to it and on which the deflector magnet is placed at the required distance, is always adjusted to have sensibly the same position with relation to the vertical force magnet; and, further, that the experiments of Table 13 exhibit no systematic difference between the deflections observed with the deflector magnet on the north arm and those with the deflector magnet on the south arm of the ring. These facts justify our regarding the determinations of the scale-coefficient obtained from the partial monthly deflections (those of Table 18) as independent determinations—subject, however, to a larger probable error than the determinations of Table 17, which are obtained from the more elaborate deflection experiments of Table 13. But the number of determinations of the former kind, in a given period, being greater than the number of the latter, the equality of weight which is lacking in individual results, will be approached in any general results—as a value of A—derived from the two series of individual values. We shall, for this reason, give the same weight to values of A derived from sets of experiments of the two different kinds; that is to say, we shall adopt a value of A that is a mean of the two independent values. Thus, calculating—by equation (12) with the constants given below it—the scale-coefficients of the times and for the temperatures of experiments XIII, XIV and XV of Table 17 we find them to be ·01019, ·01109, and ·01192, of which the mean is ·01107: the mean of the three values for those experiments, given in column 6 of Table 17 is ·01093, and half of the excess of this over the former mean (—·00007) is an additive correction to be applied to the value of A found in paragraph 55 which then becomes +·00837.

For the first period of Table 18, averaging the data of August 16 and 17, 1880, and of January 7 and 10, 1881, and taking ·000,258 as the value of b, we obtain seven equations, which when properly combined give $A = +0·01274$ and $c = ·000,010,8$ with a probable error of a single determination of the coefficient of ±·000,14: this, again, is only about a hundredth of the whole coefficient. Also calculating—by equation (12) with the above constants—the scale-coefficients of the times and for the temperatures of the experiment XI and XII of Table 17 we find them to be ·01508 and ·01437 of which the mean is ·01472: the mean of the two values given in column 6 of Table 17 for those experiments is ·01508, and half the excess of this over the former mean (+·00018) is an additive correction to be applied to the above stated value of A, which then becomes +·01292.

64. The order in which deflection experiments have been made upon the vertical force magnetograph has been generally to bring the deflector magnet up, step by step, from a distant to a near position, then to reverse the direction of the deflector and move it again, step by step, to the distant position, and finally to repeat the operations in the same order, with the deflector moved over to the other arm of the deflection ring; but another order, shown in Fig. 52, has been to complete the experiment for each single distance by itself, and then proceed with the other distances one by one. It is obvious, however, that in the last case the uncertainty due to unreversed molecular changes of the vertical force magnet will be greater than in the first case, since the individual disturbances are greater, and the comparatively irregular progression of the points in Figs. 13 to 20 as compared with those in Figs. 5, 6 and 9 to 12 shows that this is really the case. The former order has again been reverted to, and readings are taken with the magnet right away at the beginning and end of each half of the experiment: and, to eliminate as far as possible any change of zero position—whether due to change of vertical force or change of the magnet—the four sets of readings are practically corrected to a constant value of the scale-reading with the magnet away.

65. Reverting now to Table 17 with special reference to the periods April 11, 1872 to July 3, 1876, and August 8, 1876 to January 12, 1880, we first remark that the experiment of June 29, 1876 (V of Table 4), was made rather to discover whether the instrument is subject to large variations of sensitiveness according as the deflections are very small or of considerable magnitude, than with a view to its yielding an absolute value of the coefficient: it answers its main purpose satisfactorily—giving a negative reply

to the question put, but the small range of the deflection (less than a single scale-division) renders it unsuitable, and it will not therefore be used, for the other purpose. The same objection applies, in less degree, to that part of the experiment of the 11th April 1872 of which the range of the useful deflections is only 1·65 divisions, and accordingly we take the mean of the two coefficients for that date (·00771 and ·00792) by weighting them in proportion to the respective deflection ranges (5·17 and 1·65) obtaining the result ·00776. For September 12 and 13, 1873, June 30, 30 and July 3, 1876, and February 8 and 10, 1879, we take the simple means of the separate values, obtaining ·00835, ·01147, and ·00893 respectively. Table 17 thus, and otherwise, contracted becomes :—

TABLE 19.

Date — or mean date.	Experiment — or Experiments.	$(X+\frac{Wg}{m}c\ sin\ \epsilon)a$ — or mean.	V. F. Magnet h thermometer. — or mean.	Time reckoned in months from T_0 — T
				[T_0=1872·0]
11th April 1872	IIa and IIb	·00776	90·2	3·4
12—13th September 1873	III and IV	·00835	88·7	20·4
30th June—3rd July 1876	Va, Vb and Vc	·01147	93·2	54·1
				[T_0=1876·0]
8th August 1876	VI	·00949	91·0	7·3
3rd May 1877	VII	·00982	91·3	16·1
10th November 1877	VIII	·01000	92·5	22·3
8—10th February 1879	IXa and IXb	·00893	87·8	37·3
12th January 1880	X	·00872	84·5	48·4

Adopting +·000,258 as the value of b, the other constants of equation (12) given by the data of this table are for the first and last periods respectively A=+·00492, c=+·0000580 ; and A=+·00648, c=+·0000183 ; and the respective probable errors of a determination are ·000,00 and ±·000,12.

66. In Table 20 are collected together the adopted values of the constants of equation (12) for the several periods to which they apply :—

TABLE 20.

Period.		Adopted values of constants in equation Coefficient = $A+b\ (t-80°)+c\ T$.				
Beginning.	End.	T_0 Year.	T_0 Month.	A	b	c
1st May 1872	6th July 1876	1872	0·5*	+·00495	+·000258	+·0000580
10th July 1876	13th January 1880 ...	1876	0·5	+·00649	+·000258	+·0000183
22nd January 1880 ...	10th January 1881 ..	1880	0·5	+·01293	+·000258	+·0000108
12th January 1881 ...	26th June 1882... ...	1881	0·5	+·00832	+·000258	+·0000446

67. In order now to find the value of $\frac{dY}{dx}$ for any particular time, temperature, and scale-reading, what we have to do is first to calculate, by equation (12) and the proper constants taken from Table 20, the value of $(X+\frac{Wg}{m}c\ sin\ \epsilon)\ a$; and then to calculate the value of $\frac{Wg}{m}(wo)$, by multiplying the number in column 4 b of Table 16—corresponding to the particular scale-reading†—by the appropriate value of $\frac{46108}{12}\frac{Wg}{m}$: with these two numbers equation (7 a) give

$$\frac{dY}{dx}=(X+\frac{Wg}{m}c\ sin\ \epsilon)\ a-\frac{Wg}{m}\frac{\Delta(wo)}{\Delta s}$$

*For convenience of calculation these numbers are all made 0·5, and complementary changes are made in the values of A.

†Or rather its value read off from the free-hand curve of Fig. 50.

Table 21 exhibits the data for this calculation for each month* from May 1872 to June 1882, and the value of $\frac{dY}{ds}$ derived from them, as also the values of $\frac{dY}{di}$, the variation of Y *per* inch of increase of the ordinates of the vertical force magnetograms.

TABLE 21.

Calculation of the scale-coefficients of the vertical force magnetograph for each month from May 1872 to June 1882.

$A = +\cdot00495$; $b = +\cdot000258$; $c = +\cdot0000580$; $T_0 = 1872\cdot5$ Year. Month.

Constants.	Month.	$t-80$	T	$b(t-80)$	cT	$A+b(t-80)+cT$	e	$\frac{Wg}{m}\frac{\Delta(wo)}{\Delta s}$	Column 7 *minus* Column 9 $\frac{dY}{ds}$	$\frac{dY}{di}$
1	2	3	4	5	6	7	8	9	10	11
	May 1872	12·8	4	·003302	·000232	·00848	37·48	·00040	·00808	·0438
	June "	14·0	5	·003612	·000290	·00885	36·68	·00016	·00869	·0472
	July "	11·0	6	·002838	·000348	·00814	36·87	·00021	·00793	·0430
	August "	9·0	7	·002322	·000406	·00768	36·92	·00022	·00746	·0405
	September "	8·5	8	·002193	·000464	·00761	36·56	·00015	·00746	·0405
	October "	8·5	9	·002193	·000522	·00766	36·16	·00008	·00758	·0411
	November "	8·3	10	·002141	·000580	·00767	35·89	·00005	·00762	·0413
	December "	8·5	11	·002193	·000638	·00778	35·54	·00000	·00778	·0422
	January 1873	6·6	12	·001703	·000696	·00735	35·90	·00005	·00730	·0396
	February "	6·6	13	·001703	·000754	·00741	35·46	·00000	·00741	·0402
	March "	7·5	14	·001935	·000812	·00770	34·97	·00000	·00770	·0418
	April "	10·5	15	·002709	·000870	·00853	34·00	·00000	·00853	·0463
	May "	12·2	16	·003148	·000928	·00903	33·30	·00000	·00903	·0490
	June "	12·6	17	·003251	·000986	·00919	32·72	·00000	·00919	·0499
	July "	9·6	18	·002477	·001044	·00847	33·04	·00000	·00847	·0460
	August "	8·4	19	·002167	·001102	·00822	33·07	·00000	·00822	·0446
	September "	7·8	20	·002012	·001160	·00812	32·87	·00000	·00812	·0441
	October "	7·8	21	·002012	·001218	·00818	32·74	·00000	·00818	·0444
	November "	7·8	22	·002012	·001276	·00824	32·64	·00000	·00824	·0447
	December "	6·3	23	·001625	·001334	·00791	32·77	·00000	·00791	·0429
	January 1874	3·8	24	·000980	·001392	·00732	32·94	·00000	·00732	·0397
	February "	3·1	25	·000800	·001450	·00720	32·84	·00000	·00720	·0391
	March "	3·9	26	·001006	·001508	·00746	32·56	·00000	·00746	·0405
	April "	5·7	27	·001471	·001566	·00799	32·11	·00002	·00797	·0432
	May "	9·0	28	·002322	·001624	·00890	31·22	·00012	·00878	·0476
	June "	10·7	29	·002761	·001682	·00939	30·86	·00020	·00919	·0499
	July "	9·1	30	·002348	·001740	·00904	30·95	·00018	·00886	·0481
	August "	7·6	31	·001961	·001798	·00871	30·91	·00019	·00852	·0462
	September "	7·2	32	·001858	·001856	·00866	30·77	·00022	·00844	·0458
	October "	7·4	33	·001909	·001914	·00877	30·68	·00025	·00852	·0462
	November "	6·6	34	·001703	·001972	·00862	30·68	·00025	·00837	·0454
	December "	6·1	35	·001574	·002030	·00855	30·59	·00029	·00826	·0448
	January 1875	4·6	36	·001187	·002088	·00822	30·56	·00030	·00792	·0430
	February "	3·5	37	·000903	·002146	·00800	30·66	·00026	·00774	·0420
	March "	5·9	38	·001522	·002204	·00868	30·36	·00038	·00830	·0450
	April "	8·5	39	·002193	·002262	·00940	29·97	·00048	·00892	·0484
	May "	11·2	40	·002890	·002320	·01016	29·41	·00063	·00953	·0517
	June "	13·6	41	·003509	·002378	·01084	28·73	·00087	·00997	·0541
	July "	12·0	42	·003096	·002436	·01048	28·62	·00091	·00957	·0519
	August "	10·7	43	·002761	·002494	·01020	28·49	·00095	·00925	·0502
	September "	9·6	44	·002477	·002552	·00998	28·37	·00099	·00899	·0488
	October "	9·1	45	·002348	·002610	·00991	28·30	·00102	·00889	·0482
	November "	8·9	46	·002296	·002668	·00991	28·22	·00104	·00887	·0481
	December "	8·1	47	·002090	·002726	·00977	28·24	·00104	·00873	·0474
	January 1876	6·6	48	·001703	·002784	·00944	28·13	·00107	·00837	·0454
	February "	5·9	49	·001522	·002842	·00931	28·18	·00105	·00826	·0448
	March "	6·8	50	·001754	·002900	·00960	28·08	·00108	·00852	·0462
	April "	9·0	51	·002322	·002958	·00923	27·84	·00116	·00807	·0438
	May "	11·4	52	·002941	·003016	·01091	27·55	·00126	·00965	·0524
	June "	12·6	53	·003251	·003074	·01127	27·19	·00140	·00987	·0536
	July (1st to 6th) " ...	12·4	53·6	·003199	·003109	·01125	27·20	·00139	·00986	·0535

* It would have been, in some respects, more satisfactory to calculate and apply daily coefficients, or even more frequent values in cases of great disturbance of scale reading or temperature; but after a careful scrutiny of the records at large, we decided that no commensurate advantage would be reaped in return for the heavy labour that very frequent changes of the scale-coefficient would involve.

TABLE 21—*continued.*

Constants.	Month.	$t-80$	T	$b(t-80)$	cT	$A+b(t-80)+cT$	s	$\frac{Wg}{m}\frac{\Delta(\text{sec})}{\Delta s}$	Column 7 minus Column 9 $\frac{dY}{ds}$	$\frac{dY}{dt}$
1	2	3	4	5	6	7	8	9	10	11
$A=+\cdot00649$; $b=+\cdot000258$; $c=+\cdot0000183$; $T_0=1876$ Year. Month. 0·5	July (15th to 31st) 1876.	11·0	6·3	·002838	·000115	·00944	34·73	·00000	·00944	·0512
	August „	10·6	7	·002735	·000128	·00935	34·67	·00000	·00935	·0507
	September „	10·2	8	·002632	·000146	·00927	34·79	·00000	·00927	·0503
	October „	10·1	9	·002606	·000165	·00926	34·88	·00000	·00926	·0502
	November „	9·8	10	·002528	·000183	·00920	34·98	·00000	·00920	·0499
	December „	8·9	11	·002296	·000201	·00899	35·15	·00000	·00899	·0488
	January 1877 ...	8·0	12	·002064	·000220	·00877	35·41	·00000	·00877	·0476
	February „ ...	7·2	13	·001858	·000238	·00859	35·64	·00001	·00858	·0466
	March „ ...	8·2	14	·002116	·000256	·00886	35·46	·00000	·00886	·0481
	April „ ...	9·7	15	·002503	·000274	·00927	35·15	·00000	·00927	·0503
	May „ ...	11·8	16	·003044	·000293	·00983	34·83	·00000	·00983	·0533
	June „ ...	13·8	17	·003560	·000311	·01036	34·53	·00000	·01036	·0562
	July „ ...	13·4	18	·003457	·000329	·01028	34·73	·00000	·01028	·0558
	August „ ...	12·8	19	·003302	·000348	·01014	34·91	·00000	·01014	·0550
	September „ ...	12·1	20	·003122	·000366	·00998	34·96	·00000	·00998	·0542
	October „ ...	12·0	21	·003096	·000384	·00997	34·98	·00000	·00997	·0541
	November „ ...	11·2	22	·002890	·000403	·00978	35·19	·00000	·00978	·0531
	December „ ...	10·2	23	·002632	·000421	·00954	35·37	·00000	·00954	·0518
	January 1878 ...	7·9	24	·002038	·000439	·00897	35·99	·00006	·00891	·0483
	February „ ...	7·3	25	·001883	·000457	·00883	36·16	·00008	·00875	·0475
	March „ ...	8·4	26	·002167	·000476	·00913	35·78	·00004	·00909	·0493
	April „ ...	10·2	27	·002632	·000494	·00962	35·46	·00000	·00962	·0522
	May „ ...	12·1	28	·003122	·000512	·01012	35·06	·00000	·01012	·0549
	June „ ...	13·9	29	·003586	·000531	·01061	34·72	·00000	·01061	·0576
	July „ ...	12·0	30	·003096	·000549	·01013	35·01	·00000	·01013	·0550
	August „ ...	10·7	31	·002761	·000567	·00982	35·32	·00000	·00982	·0533
	September „ ...	10·8	32	·002786	·000586	·00986	35·21	·00000	·00986	·0535
	October „ ...	10·9	33	·002812	·000604	·00991	35·32	·00000	·00991	·0538
	November „ ...	10·3	34	·002657	·000622	·00977	35·53	·00000	·00977	·0530
	December „ ...	8·6	35	·002219	·000640	·00935	35·97	·00006	·00929	·0504
	January 1879.	6·9	36	·001780	·000659	·00893	36·25	·00009	·00884	·0480
	February (1st to 7th) „	6·6	36·6	·001703	·000670	·00886	36·27	·00010	·00876	·0475
	February (8th to 16th) „	..	...	...	...	...	...	...	...	Variable.
	February (17th to 28th) „	7·7	37·2	·001987	·000681	·00816	35·07	·00000	·00816	·0443
	March „	7·6	38	·001961	·000695	·00915	35·05	·00000	·00915	·0496
	April „	9·4	39	·002425	·000714	·00963	34·61	·00000	·00963	·0523
	May „	11·2	40	·002890	·000732	·01011	34·21	·00000	·01011	·0549
	June „	11·7	41	·003019	·000750	·01026	34·12	·00000	·01026	·0557
	July „	11·4	42	·002941	·000769	·01020	34·25	·00000	·01020	·0553
	August „	10·5	43	·002709	·000787	·00999	34·54	·00000	·00999	·0542
	September „	9·9	44	·002554	·000805	·00985	34·76	·00000	·00985	·0534
	October „	9·7	45	·002503	·000823	·00982	34·81	·00000	·00982	·0533
	November „	8·4	46	·002167	·000842	·00950	35·02	·00000	·00950	·0515
	December „	6·2	47	·001600	·000860	·00895	35·63	·00001	·00894	·0485
	January (1st to 13th) 1880.	4·2	47·7	·001084	·000878	·00845	36·14	·00008	·00837	·0454
$A=+\cdot01293$; $b=+\cdot000258$; $c=+\cdot0000183$; $T_0=1880$ Year. Month. 0·5	January (22d to 31st) 1880	...	...	...	...	...	...	...	...	Variable.
	February (1st to 15th) „	4·5	0·8	·001161	·000009	·01410	31·92	·00003	·01407	·0763
	February (16th to 29th) „	8·3	1·2	·002141	·000013	·01508	31·20	·00012	·01496	·0812
	March „	5·5	2	·001419	·000022	·01437	30·72	·00024	·01413	·0767
	April „	8·4	3	·002167	·000032	·01513	30·14	·00045	·01468	·0797
	May „	9·9	4	·002554	·000043	·01553	29·78	·00054	·01499	·0813
	June „	10·9	5	·002812	·000054	·01580	29·59	·00060	·01520	·0825
	July „	9·0	6	·002322	·000065	·01532	29·51	·00062	·01470	·0798
	August „	8·6	7	·002219	·000076	·01522	29·31	·00069	·01453	·0788
	September „	7·8	8	·002012	·000086	·01503	29·23	·00071	·01432	·0777
	October „	8·0	9	·002064	·000097	·01509	29·17	·00074	·01435	·0779
	November „	7·5	10	·001935	·000108	·01497	29·17	·00074	·01423	·0772
	December „	6·3	11	·001625	·000119	·01467	29·27	·00070	·01397	·0758
	January (1st to 7th) 1881	5·4	11·7	·001393	·000126	·01445	29·34	·00068	·01377	·0747

TABLE 21—*continued.*

Constants.	Month.	$t-80$	T	$b(t-80)$	cT	$A+b(t-80)+cT$.	s	$\frac{Wg}{m}\frac{\Delta(vo)}{\Delta s}$	Column 7 minus Column 9 $\frac{dY}{ds}$	$\frac{dY}{ds}$
1	2	3	4	5	6	7	8	9	10	11
$A=+\cdot00832$; $b=+\cdot000258$; $c=+\cdot000446$; T_0 = 1881 Year, Month. 0·5	Jany. (10th to 31st) 1881	...	...	...	...	...	...	...	...	Variable.
	February 1st "	...	...	...	...	...	...	...	...	Variable.
	February (2nd to 12th) "	5·1	0·7	·001316	·000031	·00967	29·91	·00057	·00910	·0494
	Feby. (13th to 23rd) "	5·4	1·1	·001393	·000049	·00976	29·38	·00074	·00902	·0489
	Feby. (24th to 28th) "	...	...	...	...	...	...	...	...	Variable.
	March "	6·4	2	·001651	·000089	·01006	28·80	·00097	·00909	·0493
	April "	7·6	3	·001961	·000134	·01041	28·39	·00113	·00928	·0504
	May "	9·9	4	·002554	·000178	·01105	28·09	·00124	·00981	·0532
	June "	10·6	5	·002735	·000223	·01128	27·77	·00136	·00992	·0538
	July "	9·3	6	·002399	·000268	·01099	27·62	·00142	·00957	·0519
	August "	9·1	7	·002348	·000312	·01098	27·34	·00153	·00945	·0513
	September "	10·0	8	·002580	·000357	·01126	27·17	·00160	·00966	·0524
	October "	8·9	9	·002296	·000401	·01102	26·90	·00172	·00930	·0505
	November "	8·3	10	·002142	·000446	·01091	26·79	·00176	·00915	·0496
	December "	6·8	11	·001754	·000491	·01056	26·51	·00188	·00868	·0471
	January 1882	6·1	12	·001574	·000535	·01043	26·24	·00199	·00844	·0458
	February "	5·5	13	·001419	·000580	·01032	26·00	·00210	·00822	·0446
	March "	6·2	14	·001600	·000624	·01054	25·94	·00213	·00841	·0456
	April "	8·2	15	·002116	·000669	·01110	26·10	·00206	·00904	·0491
	May "	10·3	16	·002657	·000714	·01169	26·10	·00206	·00963	·0523
	June (1st to 26th) "	10·6	16·9	·002735	·000754	·01181	25·96	·00212	·00969	·0526

68. The angle of the agate prism which forms the knife-edge of the vertical force magnet is very nearly 60°, and its faces, except close up to the edge, are flat. In December 1871 the knife-edge was carefully examined with a microscope, and the edge was found to be rounded, showing definite straight lines of intersection of the curved edge with the flat faces: the cord of the arc between these lines was measured—by placing a fine scale alongside of it—and found to be ·008 inch nearly, and the arc itself was estimated by observing the line of reflection—parallel to the edge—of a light from a fixed direction, and by turning the magnet in both directions till the illuminated line disappeared; the estimated angle of rotation of the magnet—and therefore the arc of the knife-edge—was about 80°: hence the radius of curvature of the curve of the knife-edge is (roughly) $=\frac{\cdot004}{\sin 60^\circ}=$ ·006 inch.

An irregularly formed but nearly straight line was found strongly marked in the middle of the rounded part of the knife-edge where it had rested on the agate plane, and a similar clear line was marked, but with interruptions, on the plane from end to end. These lines, of course, still remain, being due to the mutual pressure of the two surfaces—a pressure which, measured in grains on the square foot, must—considering the minuteness of the surfaces of contact—be very great. It is even conceivable that the lines imply that the pressure has produced depressions on the plane, and diminution of curvature of the knife-edge, of sufficient depth (or relative depth) to affect the sensitiveness of the instrument. In this case, as the lifting apparatus is not constructed so as to set the magnet down again with its knife-edge *exactly* on the same part of the plane on each occasion of lifting, it may be that the variation of sensitiveness with change of scale-reading is not quite the same under different adjustments of the magnet, since fresh liftings and settings always form the concluding operations of an adjustment. Herein we may perhaps find a partial explanation of the discrepancies exhibited amongst the four curves in Figs. 45 to 48, for the one that deviates most from the course of the general average curve is that of experiment III, and this experiment was made after the vertical force magnet had been, for some months, gradually twisting in azimuth so as to lift the knife-edge out of the groove in the plane in which it may be supposed ordinarily to oscillate.

69. A few other remarks may here be made on the discrepancies in question: (1) allowance for the different values of m at the times of the several experiments—as given in paragraph 47—would not materially increase the agreement of the four curves, though it would bring the first and last (those of experiments I and XVI*b*) into better accord;

(2) neither would the addition of a constant of +·0020 to the numbers in column 4 of Table 15 have any material effect, though if it could have been foreseen how great the constant, which depends on the deviation of the zero reading (39·7) from 33·2, would be, the value of Y, in equation (5*a*) should for that case have been increased by that amount; (3) neither, again, would allowance for the coefficient used for experiment II being that of the scale division 35·94 instead of that of 33·2 improve the general accord, though it would bring the results of that experiment and No. III into closer agreement: nor finally, would the adoption of as large a positive value of p for experiments II and III as for I or XVI*b* nearly obliterate the respective discrepancies. The relative greatness of the discrepancies in the extreme parts of the scale is of no importance, since the records of the instrument are all confined to readings between 25·61 and 38·26, and they are great because of the feebleness, in those parts, of the force which opposes any disturbance, and the consequent sluggishness and comparative indefiniteness of behaviour of the instrument. It should be noticed too that the average curve (Fig. 49) has its characteristic form notwithstanding some tendency of the positive values of p that we have used to convert it into a straight line or to reverse its inflexions.

70. If we take the rough measure in paragraph 68 (·006 inch), as the maximum radius of curvature of the curve of the knife-edge, the numbers in column 4*b* of Table 16 afford the requisite means for calculating the deviation, at different points, of the actual curve from the circle whose radius is ·006 inch: it will be convenient for this purpose to imagine the circle and the deviations magnified $\frac{1}{\cdot 0015}$ times, so that the length of the arc on the knife-edge corresponding to a division of the vertical force scale will become one inch: in that case the deviations, in inches, from the circle at positions corresponding to the several scale-readings are as follows:—

TABLE 22.

Scale division	23	24	25	26	27	28	29	30	31 to 36	37	38	39	40	41	42	43	44
Inch	·00197	·00137	·00091	·00057	·00033	·00017	·00007	·00002	·00000	·00001	·00003	·00009	·00020	·00037	·00062	·00097	·00143

It thus appears that at the extremity of an arc ten inches long, reckoned from the division 33 in either direction, the deviation of the curve from the circle is less than ·002 inch, or less than ·0002 of the whole arc, and the deviation diminishes rapidly as the arc diminishes. Such an approach to exactness, in a circular arc the whole actual length of which is less than a hundredth of an inch, astonishes one rather at the nicety of the workmanship displayed than at the absence in it of absolute perfection; and, again, we have to remark on the insecurity of assuming that influences apparently minute in themselves will effect only insensibly so delicate an instrument as the vertical force magnetograph. In the present state (October 1882) of the Colába instrument, a change of scale reading from 33·2 to 23 would multiply the sensitiveness by nearly four times, solely by reason of the minute deviation just spoken of; and a somewhat further change would render the instrument unstable and altogether useless.

71. We make a digression here to observe that the theory that we have propounded applies equally to the ordinary balance or weighing machine, that if the knife-edge of the Colába vertical force magnetograph were attached to the beam of a delicate balance, and that the beam was 12 inches long and the weights at the two ends, including the pans, about a pound each, then the numbers in column 4 of Table 16 tell us that the weight (say) in the right hand pan would apparently differ by $2 \times \frac{\cdot 000021}{\cdot 6} \times 7000 = \cdot 05$ grain according as the knife-edge rested on its part of minimum curvature or on the part (2° removed) corresponding to the division 9 of the vertical force magnetograph scale, and this even neglecting the difference due to the weight of the beam and after allowance had been made for the rate at which a small weight changed the inclination of the beam when resting in the firstnamed position. The difference would, obviously, disappear if this last rate were taken between the same limiting positions of the beam as the two weighings, but it is the practice of experimenters to adopt a uniform rate as applicable to weighings in all positions, a practice which, in this case, would necessarily lead to considerable inconsistencies, and possibly to a sensible error in the finally adopted weight. Whether or not the form of any particular knife-edge is such as to give rise to sensible error is matter for experiment, and possibly the method by which the character of the Colába vertical force magnetograph knife-edge has been learned, might with advantage be applied to knife-

edges intended to be attached to the beams of high-class balances, as well as to the knife-edge of the particular balance that was used for the determination of the weights of the Imperial Standard Pound and its copies.

72. At this stage of our present task we were led to consult the paper by Professor W. H. Miller "on the Construction of the New Standard Pound" (Philosophical Transactions, 1856, page 753); and we found from it that the balance used was constructed by Barrow, had a beam 15·06 inches long, and steel knife-edges and quartz planes; and, in some respects, behaved—as will be seen by the subjoined extract from Dr. Miller's paper—in a most remarkably similar manner to the Colába vertical force magnetograph as the behaviour of this is described in the preceding pages:—

> Page 765. "In the course of making the preliminary observations some peculiarities of the instrument were discovered, which, though they probably exist in other balances, do not appear to have been hitherto noticed. One of these is, that the expansion of one arm by heat, the left in the present case, is a little greater than that of the other arm. Hence, when the weights in the two pans are nearly equal and of equal volume, the reading of the scale in the position of equilibrium diminishes as the temperature of the beam increases. Another is, that the sensibility of the balance, as measured by the number of parts of the scale equivalent to a given weight, was found to diminish with an increase of temperature. The cause of this is obvious. The beam being of bronze and the knife-edges of steel, the balance-beam becomes an over-compensated pendulum, and an increase of temperature increases the distance between the middle knife-edge and the centre of gravity of the beam and weights, supposing the latter concentrated in the extreme knife-edges. Possibly also, the flexure of the beam may increase with the temperature, or the mean expansion of the upper bar of the beam may be greater than that of the under bar. The variation of the sensibility of the balance is so large, that it is necessary to determine the weight equivalent to a given number of parts of the scale for each set of observations, except in cases where the temperature is very nearly the same."

In Dr. Miller's repetitions of any single weighing the range of variation of the position of the beam is generally small, but in at least one instance it is over 3°: although a revision of the calculations, with a definite knowledge of the character of the knife-edge of the balance, would therefore not be likely to affect the results generally arrived at by Dr. Miller, it might, in isolated cases, lead to a modification of the results by quantities much exceeding the probable error of the average of a set of weighings. The method, adopted in the paper, of averaging a set of weighings and a corresponding set of scale-readings implies the assumption that the weights vary uniformly with the scale-readings. No account has been found of the method of determining the rate of this variation—whether for different parts of the scale or only for nearly the whole range of it.

Temperature-Coefficient of the Vertical Force Magnetograph.

73. Towards the end of the year 1878 a portable copper stove with chimney was provided for the purpose of heating the rooms in which the magnetographs and magnetometers are placed: coal fires were lighted in the stove and regulated so as to heat the air in the magnetograph room and maintain it, at pleasure, at a required temperature. The winter season was chosen for the experiments in order that the natural temperature attainable, by causing a current of external air to flow through the room, should differ as much as possible from the highest temperature up to which it was considered prudent to heat the instruments. Five sets of heating and cooling experiments have been made, the scale-readings of the vertical force magnetograph, and the readings (in Fahrenheit degrees) of the thermometer placed in the enclosure of that instrument, being observed simultaneously at the times and with the results entered in the following table. The entries for the dates January 31 and February 1, 1881, refer to an almost abortive attempt at cooling without previous heating.

Table 23.

Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.
	h. m.		
15th February 1879.		First set of experiments.	
	6 17	35·73	86·6
	10 17a	34·13	97·8
	13 6	33·20	99·7
	14 8	33·03	100·2
	14 34	32·95	100·3
	14 49	32·91	100·8
	15 4	32·89	100·7
	15 19	32·88	100·5
	15 34	32·85	100·3
	15 49	32·81	100·6
	16 4	32·78	101·2
	16 19	32·70	102·0
24th to 26th January 1880.		Second set of experiments.	
	16 17	27·39	84·0
	22 17	27·29	84·1
	6 17	27·13	84·0
	10 17	27·03	84·1
	14 17	27·00	84·0
	16 17	26·91	84·0
	22 17	26·85	83·9
	4 34	26·71	83·1
	5 6	26·70	83·1
	5 34	26·70	83·1
	6 6	26·69	83·1
	6 34	26·65	83·0
	7 49	26·55	82·7
	8 6	26·69	91·4
30th Jan. 1880.		Third set of experiments.	
	6 17	32·91	85·6
	10 17	32·78	85·7
	11 8j	32·71	93·7
	11 19	32·66	95·1
	11 34	32·61	96·0
	11 49	32·59	96·1
	12 6	32·52	96·1
7th and 8th January 1881.		Fourth set of experiments.	
	10 36	28·99	85·5
	14 36	29·19	85·6
	16 36l	29·20	85·4
	22 36	29·15	84·9
	5 36	29·13	84·3
	6 36	29·14	84·2
	7 36	29·20	84·2
	10 36	28·84	84·4
	11 6m	28·88	84·7
	11 21	28·90	85·3
	11 36	28·90	86·1
	11 51	28·91	87·0
	12 6	28·92	88·0
	12 21	28·95	88·7
	12 36	28·99	89·5
	12 51	28·99	90·0
	13 6	28·99	90·7
	13 21	29·01	91·2
	13 36	29·02	91·7
	13 51	29·05	91·9
	14 6	29·07	92·0
	14 21	29·08	92·2

Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.
	h. m.		
15th February 1879.		First set of experiments.	
	16 34b	32·66	102·5
	16 49	32·61	102·8
	17 4	32·54	103·2
	17 19	32·48	104·0
	17 34	32·40	104·8
	17 49	32·35	104·8
	18 4	32·30	104·7
	18 19	32·25	104·6
	18 34	32·20	104·4
	18 49	32·15	104·4
	19 4	32·10	104·4
	19 19	32·10	104·1
26th January 1880.		Second set of experiments.	
	9 6	27·10	95·0
	10 6	27·29	97·5
	11 6	27·11	98·5
	11 34	27·07	99·3
	11 49	27·01	99·5
	12 6	27·00	99·8
	12 19	26·90	101·1
	12 34	26·86	101·2
	12 49	26·81	101·6
	13 4	26·80	103·5
	13 19	26·76	105·2
	13 34	26·70	106·6
	13 49	26·60	106·5
	14 6h	26·51	106·6
30th Jan. 1880.		Third set of experiments.	
	12 19	32·51	96·0
	12 34	32·51	96·0
	12 49	32·51	95·9
	13 4	32·49	95·5
	13 19	32·48	95·3
	13 34	32·45	94·9
	13 49	32·43	94·6
8th January 1881.		Fourth set of experiments.	
	14 36	29·08	92·6
	14 51	29·07	93·0
	15 6	29·07	93·4
	15 21	29·06	93·9
	15 36	29·06	94·4
	15 51	29·04	94·6
	16 6	29·01	95·2
	16 21	29·00	95·7
	16 36	28·97	96·0
	16 51	28·94	96·3
	17 6	28·90	96·5
	17 21	28·89	96·8
	17 36	28·77	97·2
	17 51	28·74	97·7
	18 6	28·71	98·0
	18 21	28·70	98·1
	18 36	28·69	98·1
	18 51	28·66	98·5
	19 6	28·64	99·1
	19 21	28·61	99·2
	19 36	28·59	99·3
	19 51	28·58	99·4

Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.
	h. m.		
15th and 16th Feby. 1879.		First set of experiments.	
	19 34	32·09	103·9
	19 49	32·05	103·9
	20 4	32·01	103·9
	20 19	32·01	103·9
	20 34	32·00	103·8
	20 49	32·00	103·7
	21 4	31·99	103·5
	21 19	32·00	103·4
	22 49c	32·18	98·5
	23 34d	32·43	96·4
	0 4	32·66	95·3
	0 34	32·89	94·6
26th January 1880.		Second set of experiments.	
	14 19	26·45	107·0
	14 34	26·39	106·8
	14 49	26·29	106·4
	15 4	26·19	106·3
	15 19	26·09	106·2
	15 34	26·00	106·2
	15 49	25·93	106·2
	16 34i	25·77	104·9
	17 4	25·71	101·6
	17 19	25·65	99·8
	17 34	25·61	98·9
	17 49	25·58	98·0
	18 6	25·55	97·0
	18 34	25·48	96·0
30th Jan. 1880.		Third set of experiments.	
	14 6	32·42	94·1
	14 34	32·41	93·0
	15 34	32·46	91·7
	16 34	32·47	91·0
	18 34	32·50	90·5
	20 34	32·52	89·6
	22 34k	32·59	88·3
8th and 9th January 1881.		Fourth set of experiments.	
	20 6	28·57	99·4
	20 21	28·52	99·8
	20 36	28·51	100·3
	20 51	28·49	100·3
	21 6	28·47	100·4
	21 21	28·44	100·5
	21 36	28·41	100·6
	21 51	28·39	100·6
	22 6	28·35	100·7
	23 6m	28·31	100·2
	0 6	28·31	98·6
	1 6	28·32	97·7
	2 6	28·32	96·6
	3 6	28·38	95·4
	4 6	28·39	95·0
	5 6	28·41	94·4
	6 6	28·50	93·7
	7 6	28·51	93·0
	8 6	28·59	92·6
	9 6	28·50	92·4
	10 6	28·37	92·4
	11 6	28·39	92·2

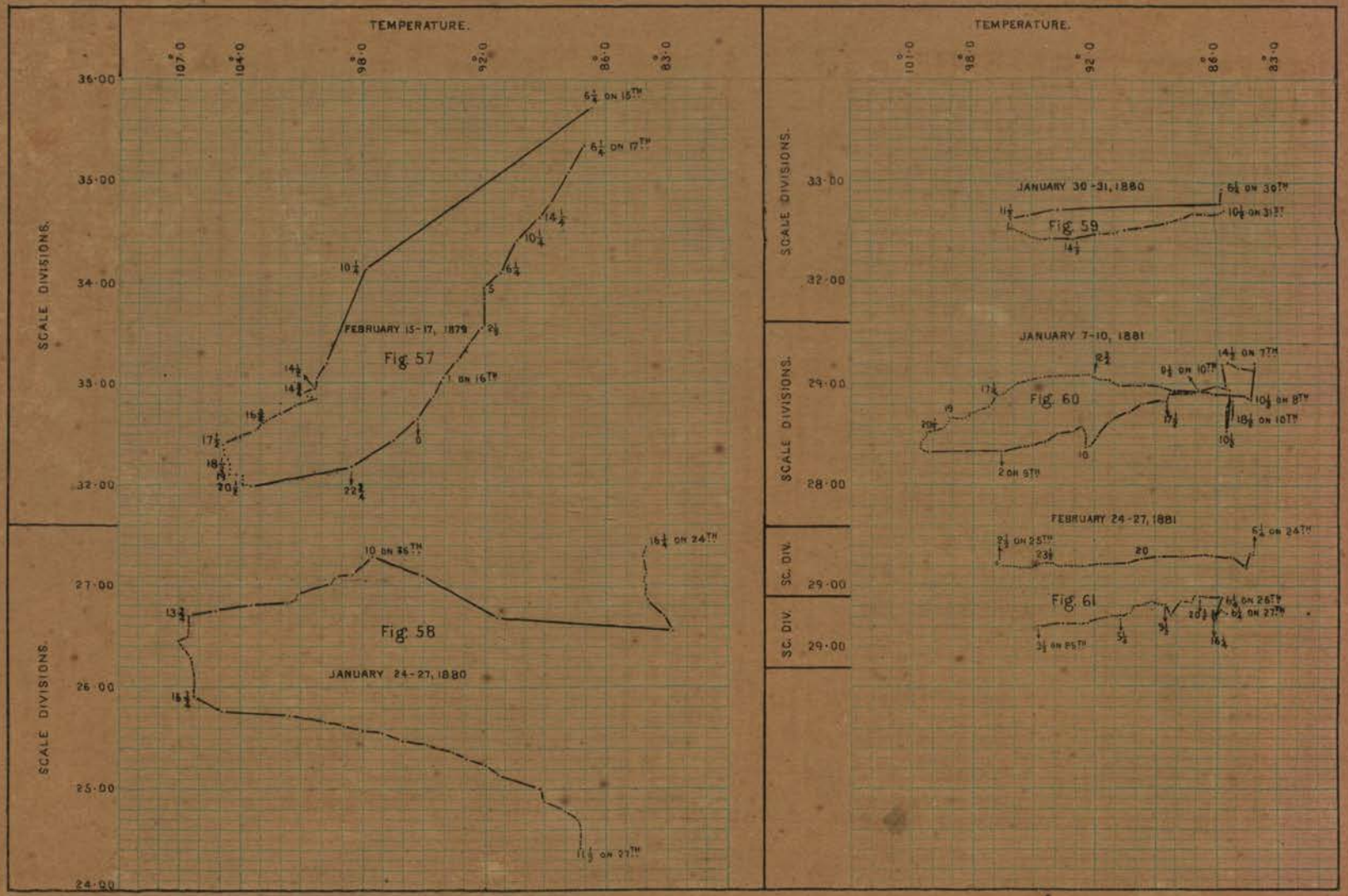
Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.
	h. m.		
16th and 17th Feby. 1879.		First set of experiments.	
	1 4	33·07	94·0
	1 34	33·23	93·3
	2 4	33·40	92·6
	2 36e	33·56	92·1
	4 4	33·85	92·0
	5 4	33·95	92·0
	6 17	34·10	91·2
	10 17	34·42	90·4
	14 17	34·65	89·2
	16 17	34·78	88·8
	22 17	35·10	87·8
	6 17	35·35	87·0
26th and 27th January 1880.		Second set of experiments.	
	19 4	25·42	94·8
	19 34	25·40	94·3
	20 6	25·36	93·5
	20 34	25·30	92·9
	21 34	25·22	92·0
	22 34	25·15	91·4
	0 34	25·00	89·3
	2 34	24·89	89·0
	4 34	24·79	88·0
	6 34	24·69	87·4
	8 34	24·60	87·2
	10 34	24·49	87·2
	11 34	24·41	87·2
31st Jan. 1880.		Third set of experiments.	
	0 34	32·63	87·6
	2 34	32·67	87·0
	4 34	32·67	86·4
	6 34	32·69	85·8
	8 34	32·71	85·5
	10 34	32·71	85·5
9th and 10th January 1881.		Fourth set of experiments.	
	11 36	28·40	92·0
	12 36	28·48	91·8
	13 36o	28·62	91·1
	14 36	28·71	90·2
	15 36	28·80	89·6
	16 36	28·82	88·6
	17 36p	28·82	88·5
	18 36	28·90	88·3
	19 36	28·90	88·0
	20 36	28·90	87·7
	21 36	28·90	87·2
	22 36	28·91	87·1
	0 36	28·92	86·8
	3 36	28·97	85·9
	6 36	28·94	85·3
	10 36	28·52	85·5
	14 36q	28·79	85·5
	16 36	28·82	85·2
	18 36r	28·65	85·2

a. Fire made in the magnetograph room at 7h. 2m.
b. No more coals added after this time.
c. Removed the fire away between 21h. 30m. and 22h. 15m. and opened the doors and ventilators.
d. Fire made in the upper stove at 23h.
e. Removed the fire away from upper stove at 2½h. on the 16th.
f. Fire made in the upper stove at 18h. on the 25th and kept burning till 7 a.m. on the 26th.
g. Reading just taken when the fire was brought into the room.
h. No more coals added after this time.
i. Fire removed away at about 16h. and doors and ventilators opened.
j. Reading taken after the fire had been lighted for some time.
k. Doors and ventilators opened about 21½h.
l. Fire made in the upper stove at about 14½h. and ventilators and doors opened.
m. Fire made in the Magnetograph room at 10h. 48m.
n. No more coals added after 22½h.
o. Doors and ventilators opened at 15h. 14m.
p. Vigorous fire made in the upper stove at 17h. 18m.
q. Fire taken away from the upper stove at 10h. 50m.
r. Doors closed at 19h.

COLABA VERTICAL FORCE MAGNETOGRAPH.

HEATING AND COOLING EXPERIMENTS.

Plate V.



THE NUMBERS PLACED ALONG THE COURSE OF THE CURVES ARE HOURS OF THE DAY.

TABLE 23—*continued.*

Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.	Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.	Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.	Date.	Colaba mean time.	Vertical Force Magnetograph. Scale-reading.	Vertical Force Magnetograph. Thermometer.
						Single cooling experiment.									
31st Jany. and 1st Feby. 1881.	h. m. 22 36a	30·56	84·4	1st Feby. 1881.	h. m. 5 36	30·49	83·0	1st Feby. 1881.	h. m. 7 36	30·34	83·1	1st Feby. 1881.	h. m. 9 36	30·43	83·3
	4 36	30·51	83·1		6 36	30·50	83·0		8 36	30·34	83·1		10 36b	30·47	83·5
						Fifth set of experiments.									
24th February 1881.	6 17c	29·30	84·2	24th and 25th February 1881.	21 36	29·20	92·9	25th February 1881.	2 6	29·23	96·8	25th to 27th February 1881.	7 21	29·42	89·4
	8 6	29·32	84·2		21 51	29·20	93·1		2 21	29·23	96·7		7 36	29·43	89·2
	10 17	29·31	84·4		22 6	29·20	93·2		2 36	29·22	96·7		8 36	29·41	88·8
	14 17	29·31	84·4		22 21	29·20	93·6		3 36e	29·20	94·7		9 36	29·41	88·5
	16 17	29·19	84·5		22 36	29·20	93·7		3 51	29·21	93·5		10 17	29·31	88·3
	18 21d	29·28	85·3		22 51	29·22	94·0		4 6	29·21	92·7		12 36	29·44	87·7
	18 36	29·29	86·1		23 6	29·22	94·1		4 21	29·22	92·3		14 17	29·44	87·5
	18 51	29·30	86·7		23 21	29·22	94·5		4 36	29·27	91·7		16 17	29·42	87·2
	19 6	29·29	87·2		23 36	29·22	94·6		4 51	29·29	91·4		18 36	29·49	87·0
	19 21	29·29	87·7		23 51	29·20	94·8		5 6	29·30	91·1		20 36	29·49	86·8
	19 36	29·29	88·5		0 6	29·19	95·1		5 21	29·30	90·7		22 17	29·48	86·6
	19 51	29·28	88·8		0 21	29·19	95·2		5 36	29·31	90·4		6 17	29·48	85·8
	20 6	29·26	89·6		0 36	29·19	95·6		5 51	29·32	90·3		10 17	29·29	86·0
	20 21	29·23	90·3		0 51	29·20	96·1		6 6	29·34	90·2		14 17	29·35	86·2
	20 36	29·21	91·1		1 6	29·20	96·5		6 21	29·37	90·1		16 17	29·25	86·1
	20 51	29·21	91·7		1 21	29·21	96·8		6 36	29·39	90·0		22 17	29·35	85·8
	21 6	29·21	92·1		1 36	29·22	96·9		6 51	29·40	89·6		6 17	29·33	85·6
	21 21	29·20	92·6		1 51	29·23	96·8		7 6	29·41	89·5				

a. Cooling commenced from 18h. 1m. when the doors and ventilators were opened and a fire kindled in the upper stove.
b. Cooling operations stopped, doors closed, and fire in upper stove put out at 12h. 46m.
c. Doors and ventilators left open and fire kindled in upper stove at 18h. on 23rd.
d. Heating commenced at 18h. 8m.
e. At 3h. put out fire in the lower stove and kindled in upper one; and doors and ventilators left open.
f. Fire put out in the upper stove at 11h. 0m. on 26th; doors closed at 7h. 5m. on 27th.

The curves of Figs. 57 to 61 are constructed from the numbers in this table, taking the temperatures as abscissæ, the scale-readings as ordinates, and marking the times along the course of the curves.

74. As in the heating experiments there is no external magnetic disturbing force introduced, and as $(a_0 + a)$ is a small angle, our fundamental equation of equilibrium—equation (1)—becomes

$$Y_0 - X\,(a_0 + a) - \frac{Wg}{m}(tu) = o \qquad (14)$$

where X may be regarded as constant during a set of experiments. Let a (the north dip of the axis of the magnet) and t (the temperature) vary together, and let the partial differential coefficients of $(t\,u)$ with respect to a and t be distinguished by being enclosed by parentheses: then differentiating

$$\frac{dY_0}{dt} - X\frac{da}{dt} - \frac{Wg}{m}\left\{\left(\frac{d\,(tu)}{dt}\right) + \left(\frac{d\,(tu)}{da}\right)\frac{da}{dt} - \frac{(tu)}{m}\frac{dm}{dt}\right\} = o \qquad (15)$$

where dY_0 is the change of Y_0 that occurs during the time in which t changes from t to $t+dt$: but $tu = -c\cos(\epsilon + a) - wo$, and as a is a small angle

$$\left(\frac{d\,(tu)}{da}\right) = c\sin\epsilon - \frac{d\,(wo)}{da}; \text{ therefore, as } da = a\,ds,$$

$$\frac{dY_0}{dt} - \left(X + \frac{Wg}{m}c\sin\epsilon\right)a\frac{ds}{dt} + \frac{Wg}{m}\frac{d(wo)}{ds}\frac{ds}{dt} - \frac{Wg}{m}\left\{\left(\frac{d\,(tu)}{dt}\right) - \frac{(tu)}{m}\frac{dm}{dt}\right\} = o \qquad (16)$$

or substituting for $\left\{\left(X + \frac{Wg}{m}c\sin\epsilon\right)a - \frac{Wg}{m}\frac{d(wo)}{ds}\right\}$ its value $\frac{dY}{ds}$ [*see* equation (7*a*)]

and for $\frac{Wg}{m}(tu)$ its approximate value Y_0 [*see* equation (14)]

$$\frac{dY}{ds}\frac{ds}{dt} - \frac{d\,Y_0}{dt} = \frac{Y_0}{m}\frac{dm}{dt} - \frac{Wg}{m}\left(\frac{d\,(tu)}{dt}\right), \text{ and} \qquad (17)$$

$$\frac{ds}{dt} = \frac{\frac{Y_0}{m}\frac{dm}{dt} - \frac{Wg}{m}\left(\frac{d\,(tu)}{dt}\right) + \frac{d\,Y_0}{dt}}{\frac{dY}{ds}} \qquad (18)$$

75. Deferring, for the moment, the final reduction of the observations, we proceed now to describe the process adopted for approximately destroying the large temperature coefficient which the instrument was found to require when the first set of experiments was made, *viz.* in February 1879. The average value of $\frac{\Delta s}{\Delta t}$ for the cooling period commencing on February $15^d\ 21^h\ 15^m$ and ending on February $17^d\ 6^h$, or $\frac{35{\cdot}35-32{\cdot}00}{87{\cdot}0-103{\cdot}4} = -0{\cdot}21$, was taken as near enough for this purpose. The value of m was found in the manner described in paragraph 47 and by similar deflection experiments at the distance 1·6 foot, to be 0·5948 and 0·5755 respectively: it was also roughly determined by vibrating the vertical force magnet with and without a bar whose moment of inertia is 19·6138, and observing the respective times of vibration in seconds: the squares of these were 75·8814 and 36·2321, whence the moment of inertia (K) of the magnet and attachments is 17·9233, and $m = \frac{\pi^2 K}{XT^2} = \frac{176{\cdot}8967}{8{\cdot}1128 \times 36{\cdot}2321} = 0{\cdot}6018$—all in British units: the mean of the three values (0·5907) was made use of. Other data used were $X = 8{\cdot}1128$; ϵ, the north magnetic dip, $= 19° 20'$, whence $Y_e = 2{\cdot}8464$; $W = 1760{\cdot}1$ grains; and $g = 32{\cdot}19$. On account of resistance of the air to the motion of the mirror, times of vibration of the vertical force magnet can only be roughly observed, but combining such a rough value (4"·84) of the vibration of the magnet when in adjustment, immediately before the first heating experiments of January 1880, with the time of vibration of the same magnet in a horizontal plane, the square of which is given above, we obtain as the value of $\frac{dY}{ds}$ (in British units) $\frac{36{\cdot}2321}{(4{\cdot}84)^2} \times 8{\cdot}1128 \times {\cdot}00154 = {\cdot}0193$.* Disregarding $\frac{dY_e}{dt}$ and inserting numerical values in equation (17) we obtain

$$·0193 \times (-0{\cdot}21) = \frac{2{\cdot}8464}{·5907}\frac{dm}{dt} - \frac{1760{\cdot}1 \times 32{\cdot}19}{·5907}\left(\frac{d(tu)}{dt}\right) \qquad (19)$$

$$-·004053 = 4{\cdot}8187\frac{dm}{dt} - 95916\left(\frac{d(tu)}{dt}\right) \qquad (20)$$

76. We may form an estimate of the relative importance of the two terms on the right hand side of this equation by taking for $\frac{dm}{dt}$ —·000,2, which is not far from the value of it usually found by hot and cold water experiments. This gives for the first term the value —·000,964, and thence we obtain for the second, the value —·003,089; or the force-equivalent of the change of position of the centre of gravity of the magnet and attachments due to an increase of one degree of temperature is more than three times greater than the force-equivalent of the loss of strength of the magnet due to the same cause. Dividing —·003,089 by the coefficient (—95916) of the second term, we obtain $\left(\frac{d(tu)}{dt}\right) = +·000,000,0322$ foot, implying that the centre of gravity moves to the southward of the knife-edge by that amount for every increase of a degree of temperature. Now, neglecting the middle term, equation (14) gives for the total distance $(tu) = \frac{Y_e}{\frac{Wg}{m}} = \frac{2{\cdot}8464}{·90916} = ·000,03$ foot (nearly); whence the rate of increase of (tu) *per* unit of its length and *per* degree, is $\frac{·000,000,0322}{·000,03} = ·001$ nearly. As the knife-edge passes nearly through the centre of figure of the magnet, this is far too extravagant a rate to be attributed to any regular expansions; nor can any material part of it be accounted for by the consideration of the unsymmetrical arrangement of the attachments; for the most considerable of these is the mirror, which weighs 105 grains, and it would be necessary that the displacement of this to the south side of the knife-edge should be about an inch, in order that the expansion for one degree should move the centre of gravity of the whole mass by ·000,000,0322 foot, whilst the actual displacement is but a small fraction of an inch. Although, however, $\left(\frac{d(tu)}{dt}\right)$ is large as compared with any probable uncompensated simple expansion, it is very small in comparison with $\frac{\Delta(c \sin \epsilon)}{\Delta t}$ [=·000,043,39† inch=·000,003,62 foot] the depression of the centre of gravity due to the

* If we could have known beforehand, what has only been brought to light by an elaborate later investigation, that the high temperature of the instrument during the experiments would increase the value of the scale coefficient, this should have been about one-fourth of itself greater. It is mainly on this account that, as will be seen presently, the calculated additional compensation was found, on trial, to be one-third or one-fourth too small. In comparison with the temperature effect, the time-growth of the coefficient between February 1879 and January 1880 is insignificant.

† See paragraph 56.

same cause; and if the surmisal that the latter movement is an effect of increase of flexure of the two ends of the magnet with increase of temperature* be admissible, then it may well be that this smaller movement, which is more than a hundred times less, is caused by lateral inequality of the same molecular changes that give rise to the change of flexure, and such movement—being in this case in the same direction—would always be initiated and augmented by loss of strength of the magnet.

77. But so large a temperature-coefficient being practically highly objectionable, our first concern was to obliterate it as far as possible, from whatever cause it arose, and, as $\frac{dm}{dt}$ is beyond control, our attention had to be directed to the reduction of $\left(\frac{d(tu)}{dt}\right)$ to such an extent that 95916 $\Delta\left(\frac{d(tu)}{dt}\right)$ should be equal to $-\cdot004053$, when the coefficient ought to disappear: in other words $\Delta\left(\frac{d(tu)}{dt}\right)$ was to be made equal to $-\cdot000,000,042,3$ foot *per* degree by altering the temperature-compensation arms and the weights placed upon them. Originally these consisted of a horizontal brass arm fixed to the north side of the knife-edge frame, a zinc weight sliding stiffly upon it, and a brass socket sliding stiffly upon the south end of the magnet. The weights of these were 26 grains, 10·2 grains, and 59·45 grains respectively and the respective distances of their centres of gravity from the knife-edge 0·116 foot to northward, 0·0977 foot to northward, and 0·0643 foot to southward. Consequently, the weight of the magnet and all appendages being 1760·1 grains, and the linear expansion coefficients *per* degree Fahrenheit—of brass being ·000,010,4, of zinc being ·000,01643 and of steel being ·000,006, the parts of $\left(\frac{d(tu)}{dt}\right)$ due to the regular expansion of the respective pieces were $-\frac{26}{1760\cdot1}\times0\cdot116\times\cdot000,010,4=-\cdot000,000,0178$; $-\frac{10\cdot2}{1760\cdot1}\times0\cdot0977\times\cdot000,010,4=-\cdot000,000,008,9$; and $+\frac{59\cdot45}{1760\cdot1}\times0\cdot0643\times\cdot000,006=+\cdot000,000,013,0$. The first question put was whether the substitution of a larger weight (call it x) for the small zinc one would suffice for our purpose: to ascertain this we have only to suppose the brass socket moved on to be flush with the extreme south end of the magnet, when its distance from the knife-edge would be 0·2095 foot and—supposing the zinc weight to have been removed—the weight x acting at the very end of the brass arm—distance $=0\cdot2192$ foot, will, in order to restore the balance, have to be

$$x=\frac{59\cdot45\times(0\cdot2095-0\cdot0643)+10\cdot2\times0\cdot0977}{0\cdot2192}=43\cdot927$$

But with this weight and the changed distances the changed parts of $\left(\frac{d(tu)}{dt}\right)$ become—

for the brass socket $\frac{59\cdot45}{1760\cdot1}\times(+0\cdot2095)\times\cdot000,006=+\cdot000,000,0425$ and

for the weight x $\frac{43\cdot927}{1760\cdot1}\times(-0\cdot2192)\times\cdot000,010,4=-\cdot000,000,0569$

78. And as the brass arm is the same in both cases the sum of these two parts ($-\cdot000,000,014,4$) less the sum of the corresponding two unchanged parts ($+\cdot000,000,0130$ $-\cdot000,000,008,9=+\cdot000,000,004,1$) is the greatest change of $\left(\frac{d(tu)}{dt}\right)$ [a diminution of ·000,000,018,5] that could be produced in this way, and we see that this is not even half adequate to meet the requirements of the case. Consequently, as it seemed unadvisable to increase the size of the weights beyond that of the brass socket, we decided—after finding that this would dispense with any need of large weights—to substitute for the old brass arm a zinc arm of the same form and dimensions and so to take advantage of the greater expansibility of the former metal. Having done this, the moment (xl) of the new weight (x) to be placed on the zinc arm with its centre of gravity at the distance (l) to northward of the knife-edge, and l' the required distance of the brass socket to southward of the knife-edge, were found from the two following equations,—

$$(xl)=59\cdot45\times(l'-0\cdot0643)+10\cdot2\times0\cdot0977, \text{ and}$$

$$\left\{\left(\tfrac{59\cdot45}{1760\cdot1}\times l'\times\cdot000,006\right)-\left(\tfrac{26}{1760\cdot1}\times0\cdot116\times\cdot000,016,43\right)-\left(\tfrac{(xl)}{1760\cdot1}\times\cdot000,016,43\right)\right\}-\cdot000,000,013,7=-\cdot000,000,042,3,$$

the last term of the first side of the last equation being the sum of the unchanged three parts of $\left(\frac{d(tu)}{dt}\right)$, or $+\cdot000,000,013,0-\cdot000,000,017,8-\cdot000,000,008,9=-\cdot000,000,013,7$.

79. The first of these equations expresses the condition that the balance shall be maintained, and the second that the required change shall be effected in the value of $\left(\frac{d(tu)}{dt}\right)$: they give 6·325 for xl, and 0·154 for l'. To fix upon the best values of x and l, consistently

* See paragraph 57.

with $\mathcal{M}$ being equal to 6·325, we must have recourse to other considerations than those of the problem just solved; and if the zinc arm had been somewhat less slender than it is,* the least weight (x) that would have allowed the same effective range of further adjustment, in bringing it and the brass socket up to the ends of their respective arms, would perhaps have been the best to choose; but, as it is, we fixed upon a weight (51·9 grains) that should never project from the knife-edge by more than 0·18 foot, and this gives for l ·120 foot.

80. To allow of the various weighings, measurements, and other experiments that have been described being made the instrument had, of course, to be dismounted, and removed from its usual place. This was done on the 14th January 1880 and following days, and the fit of the brass socket upon the magnet being inconveniently tight, the opportunity was taken of easing it a little by filing a few particles off the inside of the socket.

81. On re-adjusting the magnet, with the new zinc arm and new brass weight attached, the latter was actually placed at the distance 0·128 foot from the knife-edge, and the brass socket was then roughly adjusted to restore the balance, and finally the small brass screws were turned as is customary for fine adjustment both of sensitiveness and balance. Between the 25th and 27th January 1880 the second set of heating experiments was made, but it was of no value, because the apparatus was yet in a state of gradual molecular change, was in fact taking a new "set" after the comparatively rough handling to which it had been recently exposed, and the effects of this action over-rode the effects of temperature upon the readings of the instrument. The figure (No. 58) is interesting as exhibiting this action. The third set of heating experiments was made on the 30th and 31st January 1880, and the small range of the curve (Fig. 59) shows, even after allowing for the scale-coefficient being nearly twice as great as in February 1879, that the large temperature coefficient had been substantially destroyed.† This result is confirmed, though not in quite so marked a manner by the curve of Fig. 60, which represents the fourth set of heating experiments—those of the 7th and 8th January 1881. After this, the compensation weights were again moved,‡ the brass socket so as to lie flush with the end of the magnet, and the brass weight on the zinc arm so as to restore the balance. Then, after allowing a little while for the instrument to settle down to a steady habit, the fifth and last set of heating experiments was made on the 24th—25th February 1881; and the curve representing these experiments (Fig. 61) is regarded as implying as nearly a complete obliteration of the temperature coefficient as the instrument is susceptible of receiving or as the particular kind of experiment is capable of exhibiting.

82. We now proceed to the determination of the numerical values of the temperature coefficients deducible from the numbers afforded by the several experiments. A cursory examination of the four useful curves (Figs. 57 and 59 to 61), and especially of the first which has the widest range, shows that the magnet lags behind the thermometer in taking up the changes of temperature to which the glass shade, which encloses them both, is exposed in the course of a set of experiments; for the rate of change of scale-reading *per* degree of temperature is slower in the earlier than in the later part both of the heatings and coolings,‖ and it is two or three hours after the rise of the thermometer has been finally arrested before the scale-readings cease to fall or begin to rise again even though the thermometer has in this interval fallen, in the several experiments, from one to four degrees. It was foreseen that this would render the utilization of a great part of the observations somewhat uncertain, and both high and low temperatures were maintained until in all cases, the scale-readings had become steady: ultimately we resolved to base the reductions on these steady observations alone. The periods selected as comprising observations generally of this character, that is—of times of nearly uniform higher temperature and of times of nearly uniform lower temperature, and the average scale-readings and average temperatures for these periods are shown in Table 24, as are also the scale-reading differences and temperature differences of the intervals between the respective periods (the latter being always taken with the positive sign), the sums of these differences, and the quotients $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$.

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* Its dimensions are,—length = 2·47 inches; breadth (vertical) = 0·15 inch; and thickness = 0·02 inch.

† The reason for the small deficiency in the additional compensation first applied has been explained in the foot-note to paragraph 75.

‡ The mode of calculating the amount of motion requisite to destroy the residual temperature coefficient still found to be required by the experiments of January 1880 and January 1881, is obvious from what has gone before.

‖ The fact of the general direction of the lower one-fourth of Fig. 57 being much less inclined to the horizontal than the upper three-fourths is mainly due to this cause, but—as remarked in paragraph 57—a part of it may be due to the influence of temperature on the sensitiveness of the instrument.

TABLE 24.

Period.			Vertical Force Magnetograph.				
Month.	Beginning.	End.	Scale-reading.	Differences.	Thermometer.	Differences.	$\frac{\Delta s}{\Delta t}$.
1	2	3	4	5	6	7	8
	d. h. m.	d. h. m.	First set of experiments.				
February 1879.	15 6 17	15 6 17	35·73		86·6		
	15 14 34	15 15 49	32·88	−2·85	100·6	+14·0	...
	15 19 34	15 21 19	32·02	−0·86	103·7	+ 3·1	...
	16 2 36	16 5 4	33·79	−3·33	92·0	+16·7	...
	17 6 17	17 6 17	35·35		87·0		
Sums and quotient	...	...	.....	−7·04	...	+33·8	−·208
Corresponding means	...	...	33·47	...	97·0	...	...
Temperature coefficient $= \frac{dY}{ds}\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)} = (\cdot 01156)(-\cdot 208) = -\cdot 00240$.							
	d. h. m.	d. h. m.	Third set of experiments.				
January 1880.	30 10 17	30 10 17	32·78	−0·24	85·7	+10·3	...
	30 11 34	30 12 49	32·54	+0·06	96·0	+ 5·3	...
	30 16 34	30 18 34	32·48	−0·22	90·7	+ 5·1	...
	31 6 34	31 10 34	32·70		85·6		
Sums and quotient	...	...	.....	−0·40	...	+20·7	−·019
Corresponding means	...	...	32·59	...	90·7	...	...
Temperature coefficient $= \frac{dY}{ds}\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)} = (\cdot 01570)(-\cdot 019) = -\cdot 00030$.							
	d. h. m.	d. h. m.	Fourth set of experiments.				
January 1881.	8 19 36	8 21 6	28·86	+0·50	81·5	+16·0	...
	8 21 36	8 23 6	28·36	−0·58	100·5	−15·2	...
	9 8 6	9 11 6	28·46		92·4		
	10 6 36	10 6 36	28·94		85·3		
Sums and quotient	...	...	.....	−1·08	...	+31·2	−·035
Corresponding means	...	...	28·63	...	92·7	...	...
Mean value of $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)} = -\frac{\cdot 035 + 046^*}{2} =$							−·041
Temperature coefficient $= \frac{dY}{ds}\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)} = (\cdot 01542)(-\cdot 041) = -\cdot 00063$.							
	d. h. m.	d. h. m.	Fifth set of experiments.				
February 1881.	23 22 17	24 18 21	29·29	−·07	84·6	+12·2	...
	25 1 21	25 2 36	29·22	−·26	96·8	+10·3	...
	25 18 36	26 6 17	29·48		86·5		
Sums and quotient	...	...	.....	−0·33	...	+22·5	−·015
Corresponding means	...	...	29·30	...	91·1	...	...
Temperature coefficient $= \frac{dY}{ds}\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)} = (\cdot 01047)(-\cdot 015) = -\cdot 00016$.							

* See next paragraph.

83. The only attempts made to allow for changes of the vertical force occurring in the course of a set of experiments had respect to the diurnal variation of that element and the experiments of January and February 1881: it did not increase the consistency of the several pairs of differences and it left the value of $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$ for February 1881 the same (—·015) as is found above without any such allowance: it gave for January 1881 the value —·046 to $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$, and the mean (—·041) between this and the value found above (—·035) has been adopted.

84. Periods of steady difference of temperature outside and inside the glass shade were also selected from the observations, and were divided into parts of higher and parts of lower temperature, and these parts were treated like the hot and cold periods of the preceding table. The pairs of differences were much less accordant than those of the preceding selection, and the resulting values of $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$ were, in the order of the experiments, —·201; —·037; —·047 and —·025. These have been made no use of.

85. The values of $\frac{dY}{ds}$ used in Table 24 were calculated from the data given at the foot of the table by means partly of the constants of Table 20 and partly of the numbers in columns 2, 6 and 7 of Table 16. The readings of the vacuum gauge, within the vertical force magnetograph enclosure, varied during the four useful heating experiments between 2·68 and 2·74; 1·51 and 1·55; 1·74 and 1·80; and between 2·40 and 2·43 inches of mercury, in the order of occurrence of the experiments.

86. One of the obvious practical conclusions to be drawn from the whole investigation is that the degree of sensitiveness of the instrument should be fixed with reference to the character of the particular instrument, and to the ranges of temperature and scale-reading under which it is to be used, and not on foreign considerations which assume that the scale coefficient is independent both of temperature and of the scale-reading: also that if the Colába instrument may be taken as a type of its class*—a class which consists of some fifteen copies established in various parts of the world—it would be futile to attempt to maintain uniformity of scale in the whole class, because it would be absurd to suppose the instruments varying together, in respect of temperature and scale-reading, in virtually parallel lines; and this being premised, the most suitable scale for any particular case is one that will allow (say) of a year's unbroken records being obtained without any extravagant variation of the scale-coefficient—(say) that the upper limit should not bear to the lower a greater ratio than 2 to 1—but otherwise be as open as possible consistently with the retention within the range of the recording paper of all but the most erratic disturbances.

Scale-Coefficient of the Horizontal Force Magnetograph.

87. The form of the instrument being that of the bifilar magnetometer, with a thin platinum suspension wire, the mechanical theory of it may be stated as follows:—

Let m = the magnetic moment of the magnet

X = the horizontal component of the Earth's magnetic force

l = the (single) length of the suspension wire

a = half the distance apart of the wires at top

a' = the radius of the pulley

A = the angle between the magnetic meridian and the vertical plane containing the two wires at top

v = the angle between the vertical planes containing the two wires at top and at bottom, *i.e.* the angle of torsion

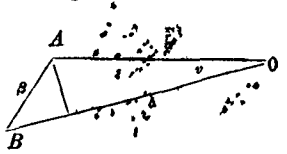
W = the mass of the magnet and its attachments

* There is no reason for presuming it to be otherwise, seeing that in order of manufacture it comes near the middle of the class as at present existing.

g = the force of gravity,

and, in Fig. 62, let a, a' be projections on a horizontal plane of the half-distance apart of the wires at the top and bottom. The equilibrium of the system may be regarded as maintained (1) by half the weight of the magnet balancing the upward tension of the wire at the point A, (2) by the re-action of the pulley against the tension of the wire acting along $A0$, and (3) by the moment round the point 0 of the horizontal tension of the wire acting at A balancing half the moment of the Earth's horizontal magnetic force acting on the magnet; and of these (1) and (3) give us

Fig. 62.



$$\tfrac{1}{2} W_g = (\text{the tension of the wire}) \times \left(1 - \frac{\beta^2}{l^2}\right)^{\frac{1}{2}} \text{ or} \qquad (a)$$

$$\text{the tension of the wire} = \tfrac{1}{2} W_g \left(1 - \frac{\beta^2}{l^2}\right)^{-\frac{1}{2}}$$

$$= \tfrac{1}{2} W_g \left(1 + \frac{\beta^2}{2l^2}\right) \text{ nearly}$$

$$= \tfrac{1}{2} W_g \left(1 + \frac{a^2 + a'^2 - 2aa' \cos v}{2l^2}\right), \text{ and} \qquad (b)$$

$$\tfrac{1}{2} mX \sin (A - v) = (\text{tension of the wire}) \frac{\beta}{l} \sin (BA0) \qquad (c)$$

$$\text{or, as } \beta \sin (BA0) = a \sin v, \qquad (d)$$

we have, inserting the value of the tension of the wire given by equation (b),

$$mX \sin (A - v) = W_g \frac{aa'}{l} \sin v \left(1 + \frac{a^2 + a'^2 - 2aa' \cos v}{2l^2}\right). \qquad (e)$$

In the Colaba instrument $l = 12{\cdot}96$ inches; $a = 0{\cdot}20$ inch; $a' = 0{\cdot}18$ inch (the last two during a particular adjustment), whence the greatest possible value of the last term of the last factor $\left(\frac{a^2 + a'^2}{2l^2}\right)$ is $\frac{{\cdot}0400 + {\cdot}0324}{336{\cdot}0} = {\cdot}00021$, and the term may—in comparison with unity—be neglected without sensible error. We then have

$$mX \sin (A - v) = W_g \frac{aa'}{l} \sin v \qquad (1)$$

and differentiating on the supposition that the temperature is constant

$$\sin (A - v)\, d(mX) + mX \cos (A - v)(dA - dv) = W_g \frac{aa'}{l} \cos v\, dv \qquad (2)$$

and dividing by (1)

$$\frac{d(mX)}{mX} = \left\{\cot v + \cot (A - v)\right\} dv - \cot (A - v)\, dA \qquad (3)$$

or, as the coefficient of the last term is necessarily kept small enough to allow of the rejection of the term

$$\frac{1}{dv} \frac{d(mX)}{mX} = \left\{\cot v + \cot (A - v)\right\} \qquad (4)$$

which, since $(A - v)$ is nearly equal to $\frac{\pi}{2}$

$$= \left\{\cot v + \left(\tfrac{\pi}{2} + v - A\right)\right\} \qquad (5)$$

Now let $v = v_0 + \Delta v$, v_0 being some arbitrarily chosen value of v that is nearly equal to $\left(A - \frac{\pi}{2}\right)$, and when Δv vanishes let $\frac{d(mX)}{mX} = \frac{d(mX)_0}{(mX)_0}$, that is

$$\frac{1}{dv} \frac{d(mX)_0}{(mX)_0} = \left\{\cot v_0 + \left(\tfrac{\pi}{2} + v_0 - A\right)\right\} \qquad (6)$$

or, subtracting this from equation (5)

$$\Delta\left\{\frac{1}{dv}\frac{d(mX)_o}{(mX)_o}\right\} = \left\{-\frac{\Delta v}{\sin^2 v_o} + \Delta v\right\} = -\cot^2 v_o\,\Delta v, \text{ and} \tag{7}$$

$$\frac{1}{dv}\frac{d(mX)}{mX} = \frac{1}{dv}\frac{d(mX)_o}{(mX)_o} - \cot^2 v_o\,\Delta v \tag{8}$$

88. Now as the north end of the magnet, when in adjustment, points nearly to westward, and as a movement of that end towards north causes an increase of scale-reading, as well as an increase of v, we may write $(s - S)a$ for Δv, S being the scale-reading corresponding to $v = v_o$, s any other scale-reading for which the coefficient $\frac{d(mX)}{mX}$ is to be found, and a being the angular value (in this case 00241) of a division of the scale. Equation (8) then becomes

$$\frac{1}{dv}\frac{d(mX)}{mX} = \frac{1}{dv}\frac{d(mX)_o}{(mX)_o} - a\,(s - S)\cot^2 v_o \tag{9}$$

89. The use that will be made of this equation is to combine series of values of $\frac{1}{dv}\frac{d(mX)}{mX}$, corresponding to certain values of s, determined by the method of deflections; thus obtaining for each period of undisturbed adjustment of the instrument appropriate values of $\frac{1}{dv}\frac{d(mX)_o}{(mX)_o}$ and $\cot^2 v_o$; and then to apply it for the calculation of monthly values of $\frac{1}{dv}\frac{d(mX)}{(mX)}$, or rather of the proper scale-coefficient $Xa\frac{1}{dv}\frac{d(mX)}{mX}$.

The deflection experiments for the determination of the scale-coefficient are similar to those described in paragraph 25 except that—in this case—the deflector magnet (E1) is placed to north or south of the deflected magnet, when used to deflect the horizontal force magnetograph, and is directed end-on towards the latter; so that the four positions, for each deflection distance, are (1) to southward with north end south; (2) to southward with north end north; (3) to northward with north end north; and (4) to northward with north end south; and the experiments are made, in the same order, successively upon the horizontal force magnetograph in adjustment, and upon the magnet N3 in the Electrometer Tower—modified, however, in the latter case, by every thing being turned through 90° of azimuth.

Tables 25, 27 and 29 contain copies of the original deflection observations of the respective kinds; and in Tables 26, 28 and 29a are collected the double deflections deduced from the observations.

TABLE 25.—*Experimental deflections of the Magnet N 3, suspended in the Electrometer Tower, by the deflector Magnet E 1.*

OBSERVATIONS.

Number and date of experiment.	Local Time.	Scale-Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
III. 11th April 1872.	11 7 30	23·55	...	1·5 E.	E.	C.C.
	" " 34	17·64	...	2·0 E.	E.	C.C.
	" " 36	14·55	81·4	3·0 E.	E.	C.C.
	" " 38	11·93	...	3·0 E.	W.	C.C.
	" " 45	8·80	...	2·0 E.	W.	C.C.
	" " 46	2·90	...	1·5 E.	W.	C.C.
	" " 50	2·83	...	1·5 W.	W.	C.C.
	" " 52	8·76	81·8	2·0 W.	W.	C.C.
	" " 54	11·91	...	3·0 W.	W.	C.C.
	" " 57	14·54	...	3·0 W.	E.	C.C.
	" " 59	17·61	...	2·0 W.	E.	C.C.
	" 8 1	23·51	81·7	1·5 W.	E.	C.C.
IV. 1st set. 10th September 1873.	10 10 21	22·74	84·2	1·5 E.	E.	V. N. and P.
	" " 24	17·68	84·2	2·0 E.	E.	
	" " 26	15·05	84·2	3·0 E.	E.	
	" " 29	12·76	84·3	3·0 E.	W.	
	" " 32	10·06	84·3	2·0 E.	W.	
	" " 35	4·93	84·4	1·5 E.	W.	
	" " 38	5·25	84·5	1·5 W.	W.	
	" " 41	10·18	84·6	2·0 W.	W.	
	" " 43	12·75	84·7	3·0 W.	W.	
	" " 45	15·03	84·8	3·0 W.	E.	
	" " 47	17·59	84·9	2·0 W.	E.	
	" " 51	22·60	85·0	1·5 W.	E.	
IV. 2nd set. 13th September 1873.	13 16 41	22·68	85·6	1·5 E.	E.	P.
	" " 42	22·67	85·5	"	"	V.N.
	" " 45	17·65	...	2·0 E.	E.	P.
	" " 46	17·65	...	"	"	V.N.
	" " 48	15·11	...	3·0 E.	E.	P.
	" " 49	15·10	...	"	"	V.N.
	" " 51	12·95	...	3·0 E.	W.	P.
	" " 52	12·97	...	"	"	V.N.
	" " 56	10·15	...	2·0 E.	W.	P.
	" " 57	10·16	...	"	"	V.N.
	" 17 0	5·06	85·7	1·5 E.	W.	P.
	" " 5	5·05	85·6	"	"	V.N.
	" " 5	5·13	85·7	1·5 W.	W.	P.
	" " 6	5·15	85·6	"	"	V.N.
	" " 10	10·15	...	2·0 W.	W.	P.
	" " 11	10·15	...	"	"	V.N.
	" " 14	12·80	...	3·0 W.	W.	P.
	" " 15	12·78	...	"	"	V.N.
	" " 18	15·06	...	3·0 W.	E.	P.
	" " 19	15·05	...	"	"	V.N.
	" " 21	17·62	...	2·0 W.	E.	P.
	" " 22	17·62	...	"	"	V.N.
	" " 24	22·60	85·6	1·5 W.	E.	P.
	" " 25	22·60	85·6	"	"	V.N.
Va. 4th October 1873.	4 16 18	14·22	85·5	Away.	...	J.E.K.
	" " 20	14·23	85·7	"	...	P.
	" " 24	15·37	85·4	3·0 E.	E.	J.E.K.
	" " 25	15·37	85·5	"	"	P.
	" " 28	17·97	...	2·0 E.	E.	J.E.K.
	" " 29	17·99	...	"	"	P.

Number and date of experiment.	Local Time.	Scale-Reading	Thermometer.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.					
Va. 4th October 1873—*continued.*	4 16 32	22·97	...	1·5 E.	E.	J.E.K.
	" " 33	22·99	...	"	"	P.
	" " 37	5·34	...	1·5 E.	W.	J.E.K.
	" " 39	5·36	...	"	"	P.
	" " 43	10·44	...	2·0 E.	W.	J.E.K.
	" " 44	10·45	...	"	"	P.
	" " 46	13·10	84·9	3·0 E.	W.	J.E.K.
	" " 46	13·09	85·0	"	"	P.
	" " 50	13·11	84·7	3·0 W.	W.	J.E.K.
	" " 51	13·12	84·7	"	"	P.
	" " 56	10·46	...	2·0 W.	W.	J.E.K.
	" " 57	10·47	...	"	"	P.
	" 17 3	5·44	...	1·5 W.	W.	J.E.K.
	" " 4	5·43	...	"	"	P.
	" " 8	22·95	...	1·5 W.	E.	J.E.K.
	" " 9	22·95	...	"	"	P.
	" " 12	17·93	...	2·0 W.	E.	J.E.K.
	" " 13	17·93	...	"	"	P.
	" " 18	15·34	84·3	3·0 W.	E.	J.E.K.
	" " 19	15·34	84·2	"	"	P.
	" " 22	14·20	84·1	Away.	...	P.
	" " 25	14·21	84·1	"	...	J.E.K.
VIa. 10th August 1876.	10 20 42	14·42	84·2	Away.	....	P.
	" " 43	14·42	84·2	"	...	V.N.
	" " 50	15·49	84·2	3·0 E.	E.	P.
	" " 51	15·49	84·2	"	"	V.N.
	" " 53	16·28	...	2·5 E.	E.	P.
	" " 54	16·28	...	"	"	V.N.
	" " 56	18·01	...	2·0 E.	E.	P.
	" " 57	18·02	...	"	"	V.N.
	" " 58	22·83	...	1·5 E.	E.	P.
	" " 59	22·83	...	"	"	V.N.
	" 21 1	5·99	...	1·5 E.	W.	P.
	" " 2	5·99	...	"	"	V.N.
	" " 4	10·82	...	2·0 E.	W.	P.
	" " 5	10·82	...	"	"	V.N.
	" " 7	12·56	...	2·5 E.	W.	P.
	" " 8	12·57	...	"	"	V.N.
	" " 10	13·33	83·8	3·0 E.	W.	P.
	" " 11	13·33	83·8	"	"	V.N.
	" " 14	13·33	83·7	3·0 W.	W.	P.
	" " 15	13·32	83·8	"	"	V.N.
	" " 17	12·55	...	2·5 W.	W.	P.
	" " 18	12·54	...	"	"	V.N.
	" " 21	10·77	...	2·0 W.	W.	P.
	" " 22	10·77	...	"	"	V.N.
	" " 25	5·77	...	1·5 W.	W.	P.
	" " 26	5·77	...	"	"	V.N.
	" " 29	23·10	...	1·5 W.	E.	P.
	" " 30	23·10	...	"	"	V.N.
	" " 33	18·09	...	2·0 W.	E.	P.
	" " 34	18·09	...	"	"	V.N.
	" " 37	16·30	...	2·5 W.	E.	P.
	" " 40	16·30	...	"	"	V.N.
	" " 41	15·49	83·8	3·0 W.	E.	P.
	" " 42	15·49	83·8	"	"	V.N.
	" " 46	14·40	83·8	Away.	...	P.
	" " 47	14·40	83·8	"	...	V.N.

TABLE 25—*continued.*

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.					
VII.	5 17 31	14·06	81·9	Away.	...	P.
	„ „ 32	14·06	81·9	„	...	V.N.
	„ „ 38	15·10	82·0	3·0 E.	E.	P.
	„ „ 39	15·11	82·0	„	„	V.N.
	„ „ 41	15·89	...	2·5 E.	E.	P.
	„ „ 42	15·89	...	„	„	V.N.
	„ „ 44	17·64	...	2·0 E.	E.	P.
	„ „ 45	17·65	...	„	„	V.N.
	„ „ 46	22·50	...	1·5 E.	E.	P.
	„ „ 47	22·51	...	„	„	V.N.
	„ „ 49	5·49	...	1·5 E.	W.	P.
	„ „ 50	5·49	...	„	„	V.N.
	„ „ 52	10·42	...	2·0 E.	W.	P.
	„ „ 53	10·41	...	„	„	V.N.
	„ „ 55	12·19	...	2·5 E.	W.	P.
	„ „ 56	12·19	...	„	„	V.N.
	„ „ 58	12·97	83·0	3·0 E.	W.	P.
	„ „ 59	12·96	83·0	„	„	V.N.
	„ 18 1	12·96	83·0	3·0 W.	W.	P.
	„ „ 2	12·96	83·0	„	„	V.N.
	„ „ 3	12·20	...	2·5 W.	W.	P.
	„ „ 4	12·20	...	„	„	V.N.
	„ „ 5	10·43	...	2·0 W.	W.	P.
	„ „ 6	10·43	...	„	„	V.N.
	„ „ 8	5·51	...	1·5 W.	W.	P.
	„ „ 8	5·51	...	„	„	V.N.
	„ „ 10	22·55	...	1·5 W.	E.	P.
	„ „ 11	22·56	...	„	„	V.N.
	„ „ 13	17·66	...	2·0 W.	E.	P.
	„ „ 14	17·66	...	„	„	V.N.
	„ „ 16	15·88	...	2·5 W.	E.	P.
	„ „ 17	15·87	...	„	„	V.N.
	„ „ 19	15·10	82·7	3·0 W.	E.	P.
	„ „ 20	15·09	82·7	„	„	V.N.
	„ „ 22	14·00	82·7	Away.	...	P.
	„ „ 23	13·99	82·7	„	...	V.N.
VIII.	22 15 31	13·97	82·0	Away.	...	P.
	„ „ 32	13·98	82·1	„	...	V.N.
	„ „ 34	14·95	...	3·0 E.	E.	P.
	„ „ 35	14·95	...	„	„	V.N.
	„ „ 37	15·72	...	2·5 E.	E.	P.
	„ „ 38	15·72	...	„	„	V.N.
	„ „ 40	17·50	...	2·0 E.	E.	P.
	„ „ 41	17·50	...	„	„	V.N.
	„ „ 42	22·40	...	1·5 E.	E.	P.
	„ „ 43	22·41	...	„	„	V.N.
	„ „ 45	5·30	...	1·5 E.	W.	P.
	„ „ 45	5·30	...	„	„	V.N.
	„ „ 47	10·25	...	2·0 E.	W.	P.
	„ „ 48	10·26	...	„	„	V.N.
	„ „ 49	12·01	...	2·5 E.	W.	P.
	„ „ 50	12·02	...	„	„	V.N.
	„ „ 52	12·80	82·1	3·0 E.	W.	P.
	„ „ 53	12·81	82·1	„	„	V.N.
	„ „ 55	12·79	82·1	3·0 W.	W.	P.
	„ „ 56	12·80	82·1	„	„	V.N.
	„ „ 58	12·00	...	2·5 W.	W.	P.
	„ „ 59	12·01	...	„	„	V.N.
	„ 16 0	10·24	...	2·0 W.	W.	P.
	„ „ 1	10·25	...	„	„	V.N.
	„ „ 3	5·37	...	1·5 W.	W.	P.
	„ „ 4	5·36	...	„	„	V.N.
	„ „ 6	22·36	...	1·5 W.	E.	P.
	„ „ 7	22·37	...	„	„	V.N.
	„ „ 9	17·50	...	2·0 W.	E.	P.
	„ „ 10	17·49	...	„	„	V.N.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.					
VIII.	22 16 12	15·74	...	2·5 W.	E.	P.
	„ „ 13	15·73	...	„	„	V.N.
	„ „ 15	14·95	81·8	3·0 W.	E.	P.
	„ „ 16	14·94	81·9	„	„	V.N.
	„ „ 18	13·88	81·9	Away.	...	P.
	„ „ 19	13·86	81·9	„	...	V.N.
IXα.	6 17 35	14·06	84·1	Away.	...	P.
	„ „ 36	14·06	84·2	„	...	V.N.
	„ „ 42	15·16	...	3·0 E.	E.	P.
	„ „ 43	15·15	...	„	„	V.N.
	„ „ 46	17·71	...	2·0 E.	E.	P.
	„ „ 47	17·70	...	„	„	V.N.
	„ „ 50	22·58	...	1·5 E.	E.	P.
	„ „ 51	22·56	...	„	„	V.N.
	„ „ 54	5·58	...	1·5 E.	W.	P.
	„ „ 55	5·56	...	„	„	V.N.
	„ „ 57	10·53	...	2·0 E.	W.	P.
	„ „ 58	10·53	...	„	„	V.N.
	„ 18 1	13·03	84·9	3·0 E.	W.	P.
	„ „ 2	13·04	84·9	„	„	V.N.
	„ „ 6	13·05	84·9	3·0 W.	W.	P.
	„ „ 7	13·04	84·9	„	„	V.N.
	„ „ 10	10·57	...	2·0 W.	W.	P.
	„ „ 11	10·57	...	„	„	V.N.
	„ „ 14	5·72	...	1·5 W.	W.	P.
	„ „ 15	5·73	...	„	„	V.N.
	„ „ 18	22·50	...	1·5 W.	E.	P.
	„ „ 19	22·48	...	„	„	V.N.
	„ „ 22	17·67	...	2·0 W.	E.	P.
	„ „ 23	17·68	...	„	„	V.N.
	„ „ 26	15·17	...	3·0 W.	E.	P.
	„ „ 27	15·16	...	„	„	V.N.
	„ „ 30	14·09	85·0	Away.	...	P.
	„ „ 31	14·10	85·1	„	...	V.N.
X.	11 15 30	14·05	81·7	Away.	...	P.
	„ „ 31	14·96	81·7	„	...	V.D.
	„ „ 40	15·20	...	3·0 E.	E.	P.
	„ „ 41	15·20	...	„	„	V.D.
	„ „ 43	13·00	...	3·0 E.	W.	P.
	„ „ 44	13·00	...	„	„	V.D.
	„ „ 47	14·09	...	Away.	...	P.
	„ „ 48	14·10	...	„	...	V.D.
	„ „ 50	13·02	...	3·0 W.	W.	P.
	„ „ 50	13·02	...	„	„	V.D.
	„ „ 53	15·19	...	3·0 W.	E.	P.
	„ „ 54	15·20	...	„	„	V.D.
	„ „ 58	14·09	81·9	Away.	...	P.
	„ „ 59	14·09	82·0	„	...	V.D.
	„ 16 1	17·65	...	2·0 W.	E.	P.
	„ „ 2	17·63	...	„	„	V.D.
	„ „ 4	10·55	...	2·0 W.	W.	P.
	„ „ 5	10·54	...	„	„	V.D.
	„ „ 7	14·08	...	Away.	...	P.
	„ „ 8	14·09	...	„	...	V.D.
	„ „ 10	10·53	...	2·0 E.	W.	P.
	„ „ 10	10·54	...	„	„	V.D.
	„ „ 14	17·66	...	2·0 E.	E.	P.
	„ „ 15	17·66	...	„	„	V.D.
	„ „ 19	14·08	82·2	Away.	...	P.
	„ „ 19	14·07	82·3	„	...	V.D.
	„ „ 30	22·45	...	1·5 E.	E.	P.
	„ „ 31	22·46	...	„	„	V.D.
	„ „ 34	5·65	...	1·5 E.	W.	P.
	„ „ 35	5·67	...	„	„	V.D.

5th February 1877.
22nd February 1877.
6th February 1878.
11th February 1879.
22nd February 1877.

TABLE 25—*continued.*

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.					
X. 11th February 1879—*continued.*	11 16 38	14·07	...	Away.	...	P.
	" " 39	14·05	...	"	...	V.D.
	" " 42	5·65	...	1·5 W.	W.	P.
	" " 43	5·64	...	"	"	V.D.
	" " 46	22·50	...	1·5 W.	E.	P.
	" " 47	22·51	...	"	"	V.D.
	" " 51	14·09	82·2	Away.	...	P.
	" " 52	14·08	82·2	"	...	V.D.
XI.* 17th April 1880.	17 19 0	13·99	90·2	Away.	...	P.
	" " 1	13·99	...	"	...	V.D.
	" " 3	15·04	...	3·0 E.	E.	P.
	" " 4	15·03	...	"	"	V.D.
	" " 6	12·95	...	3·0 E.	W.	P.
	" " 7	12·95	...	"	"	V.D.
	" " 9	14·00	...	Away.	...	P.
	" " 10	14·00	...	"	...	V.D.
	" " 12	12·92	...	3·0 W.	W.	P.
	" " 13	12·92	...	"	"	V.D.
	" " 15	15·04	...	3·0 W.	E.	P.
	" " 16	15·04	...	"	"	V.D.
	" " 18	13·99	90·1	Away.	...	P.
	" " 19	13·99	...	"	...	V.D.
	" " 22	17·53	...	2·0 W.	E.	P.
	" " 23	17·53	...	"	"	V.D.
	" " 25	10·44	...	2·0 W.	W.	P.
	" " 26	10·44	...	"	"	V.D.
	" " 29	13·97	...	Away.	...	P.
	" " 30	13·98	...	"	...	V.D.
	" " 33	10·46	...	2·0 E.	W.	P.
	" " 34	10·46	...	"	"	V.D.
	" " 37	17·51	...	2·0 E.	E.	P.
	" " 38	17·51	...	"	"	V.D.
	" " 41	13·96	89·8	Away.	...	P.
	" " 42	13·96	...	"	...	V.D.
	" " 44	22·22	...	1·5 E.	E.	P.
	" " 45	22·23	...	"	"	V.D.
	" " 48	5·64	...	1·5 E.	W.	P.
	" " 49	5·65	...	"	"	V.D.
	" " 51	13·96	...	Away.	...	P.
	" " 52	13·96	...	"	...	V.D.
	" " 54	5·59	...	1·5 W.	W.	P.
	" " 55	5·60	...	"	"	V.D.
	" " 58	22·26	...	1·5 W.	E.	P.
	" " 59	22·27	...	"	"	V.D.
	" 20 2	13·95	89·6	Away.	...	P.
	" " 3	13·95	...	"	...	V.D.

Number and date of experiment.	Local Time.	Scale Reading	Thermometer.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.					
XII. 8th June 1882.	8 19 24	14·03	86·2	Away.	...	P.
	" " 25	14·03	...	"	...	G.
	" " 29	15·10	...	3·0 E.	E.	P.
	" " 30	15·10	...	"	"	G.
	" " 33	12·96	...	3·0 E.	W.	P.
	" " 34	12·98	...	"	"	G.
	" " 38	14·04	...	Away.	...	P.
	" " 39	14·05	...	"	...	G.
	" " 42	12·98	...	3·0 W.	W.	P.
	" " 43	12·99	...	"	"	G.
	" " 47	15·10	...	3·0 W.	E.	P.
	" " 48	15·09	...	"	"	G.
	" " 52	14·04	85·5	Away.	...	P.
	" " 53	14·03	...	"	...	G.
	" " 55	15·85	...	2·5 W.	E.	P.
	" " 56	15·86	...	"	"	G.
	" " 58	12·25	...	2·5 W.	W.	P.
	" " 59	12·25	...	"	"	G.
	" 20 1	14·02	...	Away.	...	P.
	" " 2	14·00	...	"	...	G.
	" " 4	12·24	...	2·5 E.	W.	P.
	" " 5	12·25	...	"	"	G.
	" " 7	15·84	...	2·5 E.	E.	P.
	" " 7	15·85	...	"	"	G.
	" " 10	14·06	85·0	Away.	...	P.
	" " 11	14·07	...	"	...	G.
	" " 13	17·53	...	2·0 E.	E.	P.
	" " 14	17·53	...	"	"	G.
	" " 16	10·53	...	2·0 E.	W.	P.
	" " 17	10·53	...	"	"	G.
	" " 19	14·01	...	Away.	...	P.
	" " 20	14·00	...	"	...	G.
	" " 23	10·54	...	2·0 W.	W.	P.
	" " 24	10·55	...	"	"	G.
	" " 27	17·52	...	2·0 W.	E.	P.
	" " 28	17·53	...	"	"	G.
	" " 32	14·00	85·0	Away.	...	P.
	" " 33	13·99	...	"	...	G.
	" " 36	22·24	...	1·5 W.	E.	P.
	" " 37	22·23	...	"	"	G.
	" " 39	5·78	...	1·5 W.	W.	P.
	" " 40	5·79	...	"	"	G.
	" " 42	13·99	...	Away.	...	P.
	" " 43	13·99	...	"	...	G.
	" " 46	5·73	...	1·5 E.	W.	P.
	" " 47	5·72	...	"	"	G.
	" " 50	22·21	...	1·5 E.	E.	P.
	" " 51	22·21	...	"	"	G.
	" " 54	13·98	84·5	Away.	...	P.
	" " 55	13·97	...	"	...	G.

* Experiments made at night from this time, to reduce the influence of the diurnal variation of declination.

TABLE 26.—*Experimental deflections of the Magnet N3, suspended in the Electrometer Tower, by the deflector Magnet E1.*

CALCULATION, FROM THE DATA IN TABLE 25, OF THE DOUBLE DEFLECTIONS.

Number of Experiment.	Distance.	Means.		Difference or double deflection.	Double deflection.		Value of one division of Scale.*
		Higher Reading	Lower Reading		Corrected for crack in Scale.	Corrected for torsion.	
III.—11th April 1872.	3·0	14·54	11·92	2·62	...	2·62	14′·38
	2·0	17·62	8·78	8·84	...	8·85	
	1·5	23·53	2·86	20·67	...	20·69	
IV.—1st set 10th September 1873.	3·0	15·04	12·75	2·29	...	2·30	14′·34
	2·0	17·63	10·12	7·51	...	7·55	
	1·5	22·67	5·09	17·58	...	17·68	
IV.—2nd set 13th September 1873.	3·0	15·08	12·87	2·21	...	2·22	14′·37
	2·0	17·63	10·15	7·48	...	7·52	
	1·5	22·64	5·10	17·54	...	17·64	
IV.—Mean of two sets, 10th and 13th September 1873.	3·0	...	...	...	...	2·26	
	2·0	...	...	...	...	7·53	
	1·5	...	...	...	...	17·66	
Va.—4th October 1873.	3·0	15·35	13·10	2·25	...	2·26	14′·35
	2.0	17·95	10·45	7·50	...	7·54	
	1·5	22·96	5·39	17·57	...	17·66	
VIa.—10th August 1876.	3·0	15·49	13·33	2·16	...	2·17	14′·30
	2·5	16·29	12·55	3·74	...	3·76	
	2·0	18·05	10·79	7·26	...	7·30	
	1·5	22·96	5·88	17·08	...	17·18	
VII.—5th February 1877.	3·0	15·10	12·96	2·14	...	2·15	14′·31
	2·5	15·88	12·19	3·69	...	3·71	
	2·0	17·65	10·42	7·23	...	7·28	
	1·5	22·53	5·50	17·03	...	17·14	
VIII.—22nd February 1877.	3·0	14·95	12·80	2·15	...	2·16	14′·29
	2·5	15·73	12·01	3·72	...	3·74	
	2·0	17·50	10·25	7·25	...	7·30	
	1·5	22·38	5·33	17·05	...	17·16	
IXa.—6th February 1878.	3·0	15·16	13·04	2·12	...	2·12	14′·30
	2·0	17·69	10·55	7·14	*7·17	7·18	
	1·5	22·53	5·65	16·88	16·91	16·94	
X.—11th February 1879.	3·0	15·20	13·01	2·19	...	2·19	14′·30
	2·0	17·65	10·54	7·11	7·14	7·15	
	1·5	22·48	5·65	16·83	16·86	16·89	
XI.—17th April 1880.	3·0	15·04	12·93	2·11	...	2·11	14′·30
	2·0	17·52	10·45	7·07	7·10	7·11	
	1·5	22·23	5·62	16·62	16·65	16·67	
XII.—8th June 1882.	3·0	15·10	12·98	2·12	...	2·12	14′·30
	2·5	15·85	12·25	3·60	3·63	3·63	
	2·0	17·53	10·54	6·99	7·02	7·03	
	1·5	22·22	5·75	16·47	16·50	16·52	

* See first two foot-notes to Table 3.

TABLE 27.—*Experimental deflections of the Declination Magnetograph by the deflector Magnet E1.*

OBSERVATIONS.

Number and date of Experiment.	Local Time by Magnetograph Clock.*	Declination Magnetograph. Scale-reading.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.				
I. 10th August 1870.	10 10 9	22·23	Away.	...	P.
	" " 23	3·17	1·5 E.	W.	V. N.
	" " 28	14·03	2·0 E.	W.	P.
	" " 32	30·29	2·0 E.	E.	V. N.
	" " 36	30·29	2·0 E.	E.	P.
	" " 42	41·10	1·5 E.	E.	V. N.
	" " 47	41·64	1·5 W.	E.	F.C. P.
	" " 50	30·42	2·0 W.	E.	V. N.
	" " 54	30·42	2·0 W.	E.	P.
	" " 58	13·78	2·0 W.	W.	V. N.
	" 11 2	2·50	1·5 W.	W.	P.
	" " 6	22·08	Away.	...	V. N.
II. 1st November 1870.	1 11 32	22·76	Away.	...	P.
	" " 41	30·63	2·0 E.	E.	V. N.
	" " 43	30·63	2·0 E.	E.	P.
	" " 47	26·83	2·5 E.	E.	V. N.
	" " 49	26·83	2·5 E.	E.	P.
	" " 52	18·70	2·5 E.	W.	V. N.
	" " 54	18·70	2·5 E.	W.	P.
	" " 57	14·88	2·0 E.	W.	V. N.
	" " 59	14·88	2·0 E.	W.	F.C. P.
	" 12 4	14·68	2·0 W.	W.	V. N.
	" " 6	14·68	2·0 W.	W.	P.
	" " 8	18·60	2·5 W.	W.	V. N.
	" " 10	18·60	2·5 W.	W.	P.
	" " 14	26·90	2·5 W.	E.	V. N.
	" " 16	26·90	2·5 W.	E.	P.
	" " 19	30·83	2·0 W.	E.	V. N.
	" " 21	30·83	2·0 W.	E.	P.
	" " 25	22·74	Away.	...	V. N.
Vb. 4th October 1873.	4 12 19	24·10	Away.	...	P.
	" " 20	24·11	"	...	J. E. K.
	" " 28	26·05	3·0 E.	E.	J. E. K.
	" " 29	26·06	"	"	P.
	" " 34	30·58	2·0 E.	E.	J. E. K.
	" " 35	30·62	"	"	P.
	" " 39	39·23	1·5 E.	E.	J. E. K.
	" " 40	39·25	"	"	P.
	" " 45	8·84	1·5 E.	W.	J. E. K.
	" " 46	8·85	"	"	P.
	" " 50	17·55	2·0 E.	W.	J. E. K.
	" " 51	17·56	"	"	P.
	" " 55	22·18	3·0 E.	W.	P.
	" " 56	22·18	"	"	J. E. K.
	" " 59	22·10	3·0 W.	W.	J. E. K.
	" 13 0	22·13	"	"	P.
	" " 2	17·41	2·0 W.	W.	J. E. K.
	" " 3	17·44	"	"	P.
	" " 9	8·39	1·5 W.	W.	J. E. K.
	" " 10	8·39	"	"	P.
	" " 13	39·90	1·5 W.	E.	J. E. K.
	" " 14	39·94	"	"	P.
	" " 18	30·83	2·0 W.	E.	J. E. K.
	" " 19	30·86	"	"	P.
	" " 21	26·14	3·0 W.	E.	J. E. K.
	" " 22	26·13	"	"	P.
	" " 25	24·13	Away.	...	J. E. K.
	" " 26	24·14	"	...	P.
VIb. 10th August 1876.	10 14 50	24·58	Away.	...	P.
	" " 51	24·58	"	...	V. N.
	" " 54	26·45	3·0 E.	E.	P.
	" " 55	26·46	"	"	V. N.
	" " 59	27·84	2·5 E.	E.	P.
	" 15 0	27·84	"	"	V. N.
	" " 3	30·89	2·0 E.	E.	P.
	" " 4	30·89	"	"	V. N.
	" " 9	39·29	1·5 E.	E.	P.
	" " 10	39·29	"	"	V. N.
	" " 16	9·76	1·5 E.	W.	P.
	" " 17	9·76	"	"	V. N.
	" " 21	18·24	2·0 E.	W.	P.
	" " 22	18·23	"	"	V. N.
	" " 28	21·30	2·5 E.	W.	P.
	" " 29	21·31	"	"	V. N.
	" " 31	22·68	3·0 E.	W.	P.
	" " 32	22·68	"	"	V. N.
	" " 34	22·66	3·0 W.	W.	P.
	" " 35	22·66	"	"	V. N.
	" " 37	21·29	2·5 W.	W.	P.
	" " 38	21·29	"	"	V. N.
	" " 40	18·15	2·0 W.	W.	P.
	" " 41	18·15	"	"	V. N.
	" " 46	9·42	1·5 W.	W.	P.
	" " 47	9·41	"	"	V. N.
	" " 51	39·95	1·5 W.	E.	P.
	" " 52	39·95	"	"	V. N.
	" " 58	31·16	2·0 W.	E.	P.
	" " 59	31·17	"	"	V. N.
	" 16 3	28·00	2·5 W.	E.	P.
	" " 4	28·01	"	"	V. N.
	" " 7	26·59	3·0 W.	E.	P.
	" " 8	26·60	"	"	V. N.
	" " 13	24·66	Away.	...	P.
	" " 14	24·66	"	...	V. N.
IXb. 6th February 1878.	6 14 21	23·58	Away.	...	P.
	" " 22	23·57	"	...	V. N.
	" " 30	25·45	3·0 E.	E.	P.
	" " 31	25·44	"	"	V. N.
	" " 37	29·83	2·0 E.	E.	P.
	" " 38	29·83	"	"	V. N.
	" " 41	38·15	1·5 E.	E.	P.
	" " 42	38·15	"	"	V. N.
	" " 55	8·90	1·5 E.	W.	P.
	" " 56	8·89	"	"	V. N.
	" 15 2	17·26	2·0 E.	W.	P.
	" " 3	17·26	"	"	V. N.
	" " 7	21·66	3·0 E.	W.	P.
	" " 8	21·66	"	"	V. N.
	" " 13	21·65	3·0 W.	W.	P.
	" " 14	21·65	"	"	V. N.
	" " 19	17·15	2·0 W.	W.	P.
	" " 20	17·15	"	"	V. N.
	" " 24	8·49	1·5 W.	W.	P.
	" " 25	8·49	"	"	V. N.
	" " 32	38·69	1·5 W.	E.	P.
	" " 33	38·69	"	"	V. N.
	" " 38	30·00	2·0 W.	E.	P.
	" " 39	30·00	"	"	V. N.
	" " 43	25·51	3·0 W.	E.	P.
	" " 44	25·50	"	"	V. N.
	" " 49	23·59	Away.	...	P.
	" " 50	23·59	"	...	V. N.

* Reckoned from midnight.

TABLE 28.—*Experimental deflections of the Declination Magnetograph by the deflector Magnet E* 1.

CALCULATION, FROM THE DATA IN TABLE 27, OF THE DOUBLE DEFLECTIONS.

Number and date of Experiment.	Distance.	Means. Higher readings.	Means. Lower readings.	Difference or double deflection.	Value of one division of scale corrected for torsion.
I. 10th Aug. 1870.	2·0	30·34	13·90	16·44	8′·13
	1·5	41·37	2·83	38·54	...
II. 1st Novr. 1870.	2·5	26·865	18·65	8·215	8′·13
	2·0	30·73	14·78	15·95	...
V*b*. 4th Octr. 1873.	3·0	26·09	22·15	3·94	8′·13
	2·0	30·72	17·49	13·23	...
	1·5	39·58	8·62	30·96	...
VI*b*. 10th Aug. 1876.	3·0	26·52	22·67	3·85	8′·13
	2·5	27·92	21·30	6·62	...
	2·0	31·03	18·19	12·84	...
	1·5	39·62	9·59	30·03	...
IX*b*. 6th Feby. 1878.	3·0	25·47	21·65	3·82	8′·13
	2·0	29·91	17·20	12·71	...
	1·5	38·42	8·69	29·73	...

TABLE 29.—*Experimental deflections of the Horizontal Force Magnetograph by the deflector Magnet E* 1.

OBSERVATIONS.

Number and date of Experiment.	Local Time by Magnetograph Clock.*	Horizontal Force Magnetograph. Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Observer.
	d. h. m.						
I. 10th August 1870.	10 8 24	19·79	88·2	...	Away.	...	F. C.
	„ „ 38	35·58	...	...	1·5 S.	N.	„
	„ „ 46	26·54	...	...	2·0 S.	N.	„
	„ „ 50	26·56	...	...	2·0 S.	N.	„
	„ „ 54	26·52	...	...	2·0 N.	N.	„
	„ „ 58	26·55	...	...	2·0 N.	N.	„
	„ 9 2	35·60	...	...	1·5 N.	N.	„
	„ „ 11	4·50	...	...	1·5 N.	S.	„
	„ „ 17	13·52	...	...	2·0 N.	S.	„
	„ „ 20	13·52	...	...	2·0 S.	S.	„
	„ „ 30	13·56	...	...	2·0 S.	S.	„
	.....	13·56	...	...	2·0 S.	S.	„
	„ „ 36	4·56	...	...	1·5 S.	S.	„
	„ „ 41	13·57	...	...	2·0 N.	S.	„
	„ „ 46	13·59	...	...	2·0 N.	S.	„
	„ „ 49	20·10	88·6	...	Away.	S.	„
II. 1st November 1870.	1 12 26	32·94	88·2	...	Away.	...	F. C.
	„ „ 30	39·19	...	...	2·0 N.	N.	„
	„ „ 33	36·16	...	...	2·5 N.	N.	„
	„ „ 35	36·14	...	...	2·5 N.	N.	„
	„ „ 39	29·75	...	...	2·5 N.	S.	„
	„ „ 41	29·75	...	...	2·5 N.	S.	„
	„ „ 44	26·79	...	...	2·0 N.	S.	„
	„ „ 46	26·79	...	...	2·0 N.	S.	„
	„ „ 50	26·74	...	...	2·0 S.	S.	„
	„ „ 52	26·74	...	...	2·0 S.	S.	„
	„ „ 56	29·73	...	...	2·5 S.	S.	„
	„ „ 58	29·72	...	...	2·5 S.	S.	„
	„ 13 2	36·13	...	...	2·5 S.	N.	„
	„ „ 4	36·12	...	...	2·5 S.	N.	„
	„ „ 9	39·14	...	...	2·0 S.	N.	„
	„ „ 11	32·89	88·3	...	Away.	...	„
III. 10th April 1872.	10 15 1	36·65	91·7	2·74	Away.	...	C. C.
	„ „ 10	34·92	...	...	3·0 S.	S.	„
	„ „ 15	30·93	...	...	2·0 S.	S.	„
	„ „ 21	23·29	...	...	1·5 S.	S.	„
	„ „ 37	50·15†	...	...	1·5 S.	N.	„
	„ „ 43	42·39	91·6	...	2·0 S.	N.	„
	„ „ 48	38·35	...	...	3·0 S.	N.	„
	„ „ 54	38·33	91·7	...	3·0 N.	N.	„
	„ 16 0	42·29	...	...	2·0 N.	N.	„
	„ „ 6	50·06†	...	...	1·5 N.	N.	„
	„ „ 10	23·47	...	...	1·5 N.	S.	„
	„ „ 12	30·98	...	...	2·0 N.	S.	„
	„ „ 15	34·95	91·6	2·74	3·0 N.	S.	„
	.....	36·65	...	...	Away.	...	„
IV. 1st set. 11th September 1873.	11 13 25	21·35	90·3	2·61	Away.	...	P.
	„ „ „	21·35	90·0	...	„	...	J.E.K.
	„ „ 46	19·97	...	...	3·0 S.	S.	P.
	„ „ „	19·96	...	...	„	„	V.N.
	„ „ 50	16·77	...	...	2·0 S.	S.	P.
	„ „ „	16·74	...	...	„	„	V.N.
	„ 14 15	10·50	...	...	1·5 S.	S.	P.
	„ „ „	10·50	...	...	„	„	V.N.
	„ „ 26	32·30	...	...	1·5 S.	N.	P.
	„ „ „	32·32	...	...	„	„	V.N.
	„ „ 29	25·99	...	...	2·0 S.	N.	P.
	„ „ „	26·01	...	...	„	„	V.N.
	„ „ 32	22·77	90·2	...	3·0 S.	N.	P.
	„ „ „	22·72	90·3	...	„	„	V.N.
	„ „ 36	22·68	90·2	...	3·0 N.	N.	P.
	„ „ „	22·69	90·3	...	„	„	V.N.
	„ „ 40	25·93	...	...	2·0 N.	N.	P.
	„ „ „	25·94	...	...	„	„	V.N.

* Reckoned from midnight.

† Estimated by paper scale beyond 50.

TABLE 29—*continued.*

Number and date of Experiment.	Local Time by Magneto-graph Clock.	Horizontal Force Magneto-graph. — Scale-reading.	Thermo-meter.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.						
11th September 1873—*continued.* IV.	11 14 43	32·23	...	...	1·5 N.	N.	P.
	" " "	32·20	...	...	"	"	V.N.
	" " 50	10·42	...	...	1·5 N.	S.	P.
	" " "	10·36	...	...	"	"	V.N.
	" 15 10	16·62	...	...	2·0 N.	S.	P.
	" " "	16·65	...	...	"	"	V.N.
	" " 14	19·90	90·3	...	3·0 N.	S.	P.
	" " "	19·86	90·4	...	"	"	V.N.
	" " 17	21·21	...	...	Away.	...	P.
	" " "	21·24	...	...	"	...	V.N.
11th September 1873. IV. 2nd set.	11 16 19	21·22	90·2	2·61	Away.	...	P.
	" " "	21·22	90·2	2·60	"	...	V.N.
	" " 25	19·81	90·2	...	3·0 N.	S.	P.
	" " "	19·82	90·2	...	"	"	V.N.
	" " 29	16·58	...	...	2·0 N.	S.	P.
	" " "	16·58	...	...	"	"	V.N.
	" " 34	10·45	...	...	1·5 N.	S.	P.
	" " "	10·45	...	...	"	"	V.N.
	" " 39	32·14	...	...	1·5 N.	N.	P.
	" " "	32·14	...	...	"	"	V.N.
	" " 43	25·89	...	...	2·0 N.	N.	P.
	" " "	25·88	...	...	"	"	V.N.
	" " 46	22·60	90·2	...	3·0 N.	N.	P.
	" " "	22·60	90·2	...	"	"	V.N.
	" " 51	22·61	90·3	...	3·0 S.	N.	P.
	" " "	22·61	90·2	...	"	"	V.N.
	" " 55	25·86	...	...	2·0 S.	N.	P.
	" " "	25·87	...	...	"	"	V.N.
	" 17 5	32·22	...	...	1·5 S.	N.	P.
	" " "	32·21	...	...	"	"	V.N.
	" " 9	10·40	...	...	1·5 S.	S.	P.
	" " "	10·40	...	...	"	"	V.N.
	" " 13	16·58	...	...	2·0 S.	S.	P.
	" " "	16·59	...	...	"	"	V.N.
	" " 17	19·82	90·3	2·60	3·0 S.	S.	P.
	" " "	19·80	90·2	2·60	"	"	V.N.
	" " 21	21.16	90·3	2·60	Away.	...	P.
	" " "	21·16	90·2	2·60	"	...	V.N.
4th October 1873. V.	4 10 34	36·52	88·6	2·28	Away.	...	J.E.K.
	" " 35	36·50	89·1	2·28	"	...	P.
	" " 50	34·94	89·0	...	3·0 S.	S.	J.E.K.
	" " 51	34·93	89·2	...	"	"	P.
	" " 57	31·55	...	...	2·0 S.	S.	J.E.K.
	" " 58	31·52	...	...	"	"	P.
	" 11 1	25·05	...	...	1·5 S.	S.	J.E.K.
	" " 2	25·05	...	...	"	"	P.
	" " 8	47·95	...	...	1·5 S.	N.	J.E.K.
	" " 9	47·95	...	...	"	"	P.
	" " 12	41·30	...	...	2·0 S.	N.	J.E.K.
	" " 13	41·30	...	...	"	"	P.
	" " 15	37·85	89·2	...	3·0 S.	N.	J.E.K.
	" " 16	37·83	89·3	...	"	"	P.
	" " 20	37·84	89·2	...	3·0 N.	N.	J.E.K.
	" " 21	37·84	89·3	...	"	"	P.
	" " 24	41·29	...	...	2·0 N.	N.	J.E.K.
	" " 25	41·29	...	...	"	"	P.
	" " 27	47·91	...	...	1·5 N.	N.	J.E.K.
	" " 28	47·91	...	...	"	"	P.
	" " 32	24·98	...	...	1·5 N.	S.	J.E.K.
	" " 33	24·98	...	...	"	"	P.
	" " 36	31·47	...	...	2·0 N.	S.	J.E.K.
	" " 37	31·49	...	...	"	"	P.
	" " 40	34·92	89·1	...	3·0 N.	S.	J.E.K.
	" " 41	34·90	89·6	...	"	"	P.
	" " 44	36·37	89·4	2·28	Away.	...	J.E.K.
	" " 45	36·36	89·6	2·28	"	...	P.

Number and date of Experiment.	Local Time by Magneto-graph Clock.	Horizontal Force Magneto-graph. — Scale-reading.	Thermo-meter.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.						
10th August 1876. VI.	10 12 5	22·78	91·2	5·84	Away.	...	P.
	" " 6	22·78	91·1	5·85	"	...	V.N.
	" " 9	21·41	91·2	...	3·0 S.	S.	P.
	" " 10	21·41	91·1	...	"	"	V.N.
	" " 12	20·45	...	...	2·5 S.	S.	P.
	" " 13	20·46	...	...	"	"	V.N.
	" " 15	18·27	...	...	2·0 S.	S.	P.
	" " 16	18·29	...	...	"	"	V.N.
	" " 21	12·25	...	...	1·5 S.	S.	P.
	" " 22	12·26	...	...	"	"	V.N.
	" " 31	33·50	...	...	1·5 S.	N.	P.
	" " 32	33·49	...	...	"	"	V.N.
	" " 37	27·37	...	...	2·0 S.	N.	P.
	" " 38	27·38	...	...	"	"	V.N.
	" " 41	25·14	...	...	2·5 S.	N.	P.
	" " 42	25·14	...	...	"	"	V.N.
	" " 46	24·16	91·2	...	3·0 S.	N.	P.
	" " 47	24·16	91·2	...	"	"	V.N.
	" " 53	24·16	91·2	...	3·0 N.	N.	P.
	" " 54	24·17	91·2	...	"	"	V.N.
	" " 58	25·15	...	...	2·5 N.	N.	P.
	" " 59	25·15	...	...	"	"	V.N.
	" 13 2	27·36	...	...	2·0 N.	N.	P.
	" " 3	27·36	...	...	"	"	V.N.
	" " 9	33·46	...	...	1·5 N.	N.	P.
	" " 10	33·45	...	...	"	"	V.N.
	" " 18	12·29	...	...	1·5 N.	S.	P.
	" " 19	12·29	...	...	"	"	V.N.
	" " 25	18·28	...	...	2·0 N.	S.	P.
	" " 26	18·29	...	...	"	"	V.N.
	" " 29	20·47	...	...	2·5 N.	S.	P.
	" " 30	20·48	...	...	"	"	V.N.
	" " 34	21·43	91·2	...	3·0 N.	S.	P.
	" " 35	21·44	91·2	...	"	"	V.N.
	" " 38	22·77	91·2	5·84	Away.	...	P.
	" " 39	22·76	91·2	5·85	"	...	V.N.
5th February 1877. VII.	5 12 15	20·79	87·9	7·03	Away.	...	P.
	" " 16	20·79	87·9	7·03	"	...	V.N.
	" " 29	19·46	87·9	...	3·0 S.	S.	P.
	" " 30	19·47	87·9	...	"	"	V.N.
	" " 36	18·49	...	...	2·5 S.	S.	P.
	" " 36	18·49	...	...	"	"	V.N.
	" " 42	16·36	...	...	2·0 S.	S.	P.
	" " 42	16·35	...	...	"	"	V.N.
	" " 52	10·39	...	...	1·5 S.	S.	P.
	" " 53	10·39	...	...	"	"	V.N.
	" 13 2	31·40	...	...	1·5 S.	N.	P.
	" " 3	31·41	...	...	"	"	V.N.
	" " 10	25·34	...	...	2·0 S.	N.	P.
	" " 11	25·34	...	...	"	"	V.N.
	" " 16	23·14	...	...	2·5 S.	N.	P.
	" " 17	23·15	...	...	"	"	V.N.
	" " 21	22·16	88·0	...	3·0 S.	N.	P.
	" " 22	22·16	88·0	...	"	"	V.N.
	" " 26	22·15	88·0	...	3·0 N.	N.	P.
	" " 27	22·15	88·0	...	"	"	V.N.
	" " 31	23·14	...	...	2·5 N.	N.	P.
	" " 32	23·14	...	...	"	"	V.N.
	" " 36	25·34	...	...	2·0 N.	N.	P.
	" " 37	25·34	...	...	"	"	V.N.
	" " 42	31·37	...	...	1·5 N.	N.	P.
	" " 43	31·37	...	...	"	"	V.N.
	" " 52	10·40	...	...	1·5 N.	S.	P.
	" " 53	10·39	...	...	"	"	V.N.
	" " 59	16·35	...	...	2·0 N.	S.	P.
	" 14 0	16·36	...	...	"	"	V.N.
	" " 5	18·54	...	...	2·5 N.	S.	P.
	" " 6	18·54	...	...	"	"	V.N.
	" " 10	19·49	88·0	...	3·0 N.	S.	P.
	" " 11	19·48	88·0	...	"	"	V.N.
	" " 16	20·81	88·0	...	Away.	...	P.
	" " 17	20·81	88·0	...	"	...	V.N.

TABLE 29—*continued.*

Number and date of Experiment.	Local Time by Magnetograph Clock.	Horizontal force Magnetograph. Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.						
VIII	22 11 0	36·18	87·8	2·00	Away.	...	P.
	" " 2	36·18	87·8	2·00	"	...	V.N.
	" " 14	34·78	87·8	...	3·0 S.	S.	P.
	" " 15	34·78	87·8	...	"	"	V.N.
	" " 20	33·76	...	...	2·5 S.	S.	P.
	" " 21	33·76	...	...	"	"	V.N.
	" " 24	31·47	...	...	2·0 S.	S.	P.
	" " 25	31·46	...	...	"	"	V.N.
	" " 32	25·19	...	...	1·5 S.	S.	P.
	" " 33	25·20	...	...	"	"	V.N.
	" " 41	47·49	...	...	1·5 S.	N.	P.
	" " 42	47·49	...	...	"	"	V.N.
	" " 48	41·04	...	...	2·0 S.	N.	P.
	" " 49	41·05	...	...	"	"	V.N.
	" " 55	38·70	...	...	2·5 S.	N.	P.
	" " 56	38·70	...	...	"	"	V.N.
22nd February 1877.	" 12 6	37·64	87·8	...	3·0 S.	N.	P.
	" " 7	37·64	87·8	...	"	"	V.N.
	" " 13	37·64	87·8	...	3·0 N.	N.	P.
	" " 14	37·64	87·8	...	"	"	V.N.
	" " 18	38·65	...	...	2·5 N.	N.	P.
	" " 19	38·66	...	...	"	"	V.N.
	" " 23	41·03	...	...	2·0 N.	N.	P.
	" " 24	41·03	...	...	"	"	V. N.
	" " 28	47·42	...	...	1·5 N.	N.	P.
	" " 29	47·43	...	...	"	"	V.N.
	" " 36	25·10	...	...	1·5 N.	S.	P.
	" " 37	25·10	...	...	"	"	V.N.
	" " 40	31·45	...	...	2·0 N.	S.	P.
	" " 41	31·45	...	...	"	"	V.N.
	" " 48	33·75	...	...	2·5 N.	S.	P.
	" " 49	33·75	...	...	"	"	V.N.
	" " 53	34·74	87·9	...	3·0 N.	S.	P.
	" " 54	34·75	87·9	...	"	"	V.N.
	" " 59	36·17	87·9	2·00	Away.	...	P.
	" 13 0	36·17	87·9	2·00	"	...	V.N.
IX.	6 11 30	32·50	88·7	...	Away.	...	P.
	" " 31	32·49	88·7	...	"	...	V.N.
	" " 40	31·13	88·7	...	3·0 S.	S.	P.
	" " 41	31·13	88·7	...	"	"	V.N.
	" " 46	27·88	...	...	2·0 S.	S.	P.
	" " 47	27·89	...	...	"	"	V.N.
	" " 54	21·71	...	...	1·5 S.	S.	P.
	" " 55	21·71	...	...	"	"	V.N.
	" 12 9	43·50	...	...	1·5 S.	N.	P.
	" " 10	43·50	...	...	"	"	V.N.
	" " 19	37·18	...	...	2·0 S.	N.	P.
	" " 20	37·19	...	...	"	"	V.N.
	" " 25	33·87	88·8	...	3·0 S.	N.	P.
6th February 1878.	" " 26	33·88	88·8	...	"	"	V.N.
	" " 32	33·88	88·8	...	3·0 N.	N.	P.
	" " 33	33·89	88·8	...	"	"	V.N.
	" " 36	37·18	...	...	2·0 N.	N.	P.
	" " 37	37·19	...	...	"	"	V.N.
	" " 42	43·49	...	...	1·5 N.	N.	P.
	" " 43	43·51	...	...	"	"	V.N.
	" " 55	21·61	...	...	1·5 N.	S.	P.
	" " 55	21·62	...	...	"	"	V.N.
	" 13 1	27·84	...	...	2·0 N.	S.	P.
	" " 2	27·84	...	...	"	"	V.N.
	" " 5	31·06	88·9	...	3·0 N.	S.	P.
	" " 6	31·06	88·9	...	"	"	V.N.
	" " 12	32·48	88·9	...	Away.	...	P.
	" " 13	32·46	88·9	...	"	...	V.N.
X.	11 9 54	29·98	87·1	...	Away.	...	P.
	" " 55	29·99	87·1	...	"	...	V.D.
11th Feb. 1879.	" 10 4	28·63	...	...	3·0 S.	S.	P.
	" " 5	28·64	—	...	"	"	V.D.
	" " 14	31·36	...	...	3·0 S.	N.	P.
	" " 15	31·36	...	—	"	"	V.D.
	" " 19	29·99	87·1	...	Away.	...	P.

Number and date of Experiment.	Local Time by Magnetograph Clock.	Horizontal force Magnetograph. Scale-reading.	Thermometer.	Vacuum Gauge.	Magnet E1. Distance in feet.	Magnet E1. North end.	Observer.
	d. h. m.						
11th February 1879—*continued.*	11 10 20	29·99	87·1	...	Away.	...	V.D.
	" " 27	31·30	"	...	3·0 N.	N.	P.
	" " 28	31·38	...	...	"	"	V.D.
	" " 44	28·64	...	...	3·0 N.	S.	P.
	" " 45	28·64	...	...	"	"	V.D.
	" " 53	29·99	87·2	...	Away.	...	P.
	" " 54	30·00	87·2	...	"	...	V.D.
	" 11 1	25·46	...	...	2·0 N.	S.	P.
	" " 2	25·47	...	...	"	"	V.D.
	" " 13	34·66	...	...	2·0 N.	N.	P.
	" " 14	34·66	...	...	"	"	V.D.
	" " 25	30·02	...	...	Away.	...	P.
	" " 26	30·01	...	...	"	...	V.D.
	" " 31	34·65	...	...	2·0 S.	N.	P.
	" " 32	34·65	...	...	"	"	V.D.
	" " 40	25·50	...	...	2·0 S.	S.	P.
	" " 41	25·50	...	...	"	"	V.D.
	" " 48	30·03	87·3	...	Away.	...	P.
	" " 49	30·04	87·3	...	"	...	V.D.
	" " 57	19·43	...	...	1·5 S.	S.	P.
	" " 58	19·42	...	...	"	"	V.D.
	" 12 19	40·86	...	...	1·5 S.	N.	P.
	" " 20	40·87	...	...	"	"	V.D.
	" " 26	29·99	...	...	Away.	...	P.
	" " 27	29·99	...	...	"	...	V.D.
	" " 38	40·80	...	...	1·5 N.	N.	P.
	" " 39	40·80	...	...	"	"	V.D.
	" " 52	19·28	...	...	1·5 N.	S.	P.
	" " 53	19·28	...	...	"	"	V.D.
	" " 57	29·94	87·5	...	Away.	...	P.
	" " 58	29·95	87·5	...	"	...	V.D.
XI.	17 11 50	27·18	89·5	2·17	Away.	...	P.
	" " 51	27·18	89·4	2·17	"	...	V.D.
	" 12 4	25·84	...	...	3·0 S.	S.	P.
	" " 5	25·85	...	...	"	"	V.D.
	" " 21	28·51	...	...	3·0 S.	N.	P.
	" " 22	28·52	...	...	"	"	V.D.
	" " 29	27·15	...	...	Away.	...	P.
	" " 30	27·15	...	...	"	...	V.D.
	" " 36	25·82	...	...	3·0 N.	N.	P.
	" " 37	25·82	...	...	"	"	V.D.
	" " 44	28·49	...	...	3·0 N.	S.	P.
	" " 45	28·49	...	...	"	"	V.D.
	" " 51	27·10	89·5	2·17	Away.	...	P.
	" " 52	27·11	89·5	2·17	"	...	V.D.
17th April 1880.	" 13 0	31·64	...	...	2·0 N.	N.	P.
	" " 1	31·64	...	...	"	"	V.D.
	" " 10	22·65	...	...	2·0 N.	S.	P.
	" " 11	22·65	...	...	"	"	V.D.
	" " 18	27·10	...	...	Away.	...	P.
	" " 19	27·10	...	...	"	...	V.D.
	" " 26	31·62	...	...	2·0 S.	N.	P.
	" " 27	31·63	...	...	"	"	V.D.
	" " 33	22·67	...	...	2·0 S.	S.	P.
	" " 34	22·67	...	...	"	"	V.D.
	" " 43	27·10	89·6	2·17	Away.	...	P.
	" " 44	27·10	89·6	2·17	"	...	V.D.
	" " 56	16·69	...	...	1·5 S.	S.	P.
	" " 57	16·69	...	...	"	"	V.D.
	" 14 9	37·68	...	...	1·5 S.	N.	P.
	" " 10	37·68	...	...	"	"	V.D.
	" " 18	27·08	...	...	Away.	...	P.
	" " 19	27·08	...	...	"	...	V.D.
	" " 31	37·68	...	...	1·5 N.	N.	P.
	" " 32	37·68	...	...	"	"	V.D.
	" " 43	16·61	...	...	1·5 N.	S.	P.
	" " 44	16·60	...	...	"	"	V.D.
	" " 49	27·04	89·7	2·17	Away.	...	P.
	" " 50	27·04	89·7	2·17	"	...	V.D.

TABLE 29—*continued.*

Number and date of Experiment.	Local Time by Magneto-graph Clock.	Horizontal force Magneto-graph. Scale-reading.	Thermo-meter.	Vacuum Gauge.	Magnet E 1. Distance in feet.	Magnet E 1. North end.	Obser-ver.
	d. h. m.						
XII.*	7 20 33	23·34	91·7	...	Away.	...	P.
	,, ,, 34	23·34	91·7	...	,,	...	G.
	,, ,, 42	24·65	...	...	3·0 S.	N.	P.
	,, ,, 43	24·66	...	...	,,	,,	G.
	,, ,, 50	22·01	...	...	3·0 S.	S.	P.
	,, ,, 51	22·01	...	...	,,	,,	G.
	,, ,, 58	23·33	...	...	Away.	...	P.
	,, ,, 59	23·32	...	...	,,	...	G.
	,, 21 4	24·65	...	...	3·0 N.	N.	P.
	,, ,, 5	24·64	...	...	,,	,,	G.
	,, ,, 14	22·02	...	...	3·0 N.	S.	P.
	,, ,, 15	22·02	...	...	,,	,,	G.
	,, ,, 24	23·31	91·8	...	Away.	...	P.
	,, ,, 25	23·31	91·8	...	,,	...	G.
	,, ,, 36	21·08	...	...	2·5 N.	S.	P.
	,, ,, 37	21·08	...	...	,,	,,	G.
	,, ,, 45	25·58	...	...	2·5 N.	N.	P.
	,, ,, 46	25·58	...	...	,,	,,	G.
	,, ,, 52	23·32	...	...	Away.	...	P.
	,, ,, 53	23·32	...	...	,,	...	G.
	,, ,, 58	25·59	...	...	2·5 S.	N.	P.
	,, ,, 59	25·59	...	...	,,	,,	G.
	,, 22 11	21·09	...	...	2·5 S.	S.	P.
	,, ,, 12	21·10	...	...	,,	,,	G.
	,, ,, 22	23·30	91·9	...	Away.	...	P.
XII.	7 22 23	23·31	91·9	...	Away.	...	G.
	,, ,, 33	18·96	...	...	2·0 S.	S.	P.
	,, ,, 34	18·97	...	...	,,	,,	G.
	,, ,, 44	27·74	...	...	2·0 S.	N.	P.
	,, ,, 45	27·74	...	...	,,	,,	G.
	,, ,, 52	23·32	...	...	Away.	...	P.
	,, ,, 53	23·32	...	...	,,	...	G.
	,, 23 0	27·74	...	...	2·0 N.	N.	P.
	,, ,, 1	27·74	...	...	,,	,,	G.
	,, ,, 8	19·00	...	...	2·0 N.	S.	P.
	,, ,, 9	19·00	...	...	,,	,,	G.
	,, ,, 17	23·37	91·9	...	Away.	...	P.
	,, ,, 18	23·38	91·9	...	,,	...	G.
	,, ,, 27	13·19	...	...	1·5 N.	S.	P.
	,, ,, 28	13·20	...	...	,,	,,	G.
	,, ,, 39	33·69	...	...	1·5 N.	N.	P.
	,, ,, 40	33·70	...	...	,,	,,	G.
	,, ,, 47	23·38	...	...	Away.	...	P.
	,, ,, 48	23·38	...	...	,,	...	G.
	,, ,, 56	33·75	...	...	1·5 S.	N.	P.
	,, ,, 57	33·75	...	...	,,	,,	G.
	8 0 6	13·21	...	...	1·5 S.	S.	P.
	,, ,, 7	13·22	...	...	,,	,,	G.
	,, ,, 16	23·32	91·9	...	Away.	...	P.
	,, ,, 17	23·33	91·9	...	,,	...	G.

7th June 1882.

7th June 1882—*continued.*

* Experiments made at night from this time, to reduce the influence of the diurnal variation of horizontal force.

TABLE 29 *a.*—*Experimental deflections of the Horizontal Force Magnetograph by the deflector Magnet E* 1.

CALCULATION, FROM THE DATA IN TABLE 29, OF THE DOUBLE DEFLECTIONS.

Number and date of Experiment.	Distance.	Means. Higher readings.	Means. Lower readings.	Difference or double deflection.	Value of one division of scale.
I. 10th August 1870.	2·0	26·54	13·54	13·00	8′·29
	1·5	35·59	4·53	31·06	...
II. 1st Nov. 1870.	2·5	36·14	29·74	6·40	8′·29
	2·0	39·16	26·76	12·40	...
III. 10th April 1872.	3·0	38·34	34·93	3·41	8′·29
	2·0	42·34	30·95	11·39	...
	1·5	50·10	23·38	26·72	...
IV. 1st set 11th Septr. 1873.	3·0	22·71	19·92	2·79	8′·29
	2·0	25·97	16·69	9·28	...
	1·5	32·26	10·44	21·82	...
IV. 2nd set 11th Septr. 1873.	3·0	22·60	19·81	2·79	8′·29
	2·0	25·87	16·58	9·29	...
	1·5	32·18	10·42	21·76	...
IV. Mean of two sets 11th Septr. 1873.	3·0	...	...	2·79	...
	2·0	...	...	9·28	...
	1·5	...	...	21·79	...
V. 4th October 1873.	3·0	37·84	34·92	2·92	8′·29
	2·0	41·29	31·51	9·78	...
	1·5	47·93	25·01	22·92	...
VI. 10th August 1876.	3·0	24·16	21·42	2·74	8′·29
	2·5	25·14	20·46	4·68	...
	2·0	27·37	18·28	9·09	...
	1·5	33·47	12·27	21·20	...
VII. 5th Feby. 1877.	3·0	22·15	19·47	2·68	8′·29
	2·5	23·14	18·51	4·63	...
	2·0	25·34	16·35	8·99	...
	1·5	31·39	10·39	21·00	...
VIII. 22nd Feby. 1877.	3·0	37·64	34·76	2·88	8′·29
	2·5	38·68	33·75	4·93	...
	2·0	41·04	31·46	9·58	...
	1·5	47·46	25·15	22·31	...
IX. 6th Feby. 1878.	3·0	33·88	31·09	2·79	8′·29
	2·0	37·18	27·86	9·32	...
	1·5	43·50	21·66	21·84	...
X 11th Feby. 1879.	3·0	31·36	28·64	2·72	8′·29
	2·0	34·65	25·48	9·17	...
	1·5	40·83	19·35	21·48	...
XI. 17th April 1880.	3·0	28·50	25·83	2·67	8′·29
	2·0	31·63	22·66	8·97	...
	1·5	37·68	16·65	21·03	...
XII. 7th June 1882.	3·0	24·65	22·01	2·64	8′·29
	2·5	25·58	21·09	4·49	...
	2·0	27·74	18·98	8·76	...
	1·5	33·72	13·20	20·52	...

90. As, in the case of the horizontal force magnetograph, there is no question about the practical uniformity of the scale-coefficient in different parts of the scale, it is allowable at once to compare together two sets of corresponding deflections; and if the magnetism of the two magnets—N3 and that of the force magnetograph—is similarly distributed the quotient $(\frac{d'}{d})$ of the respective deflections will be independent of the deflection distance; but if otherwise the corrected quotient will be $d'\left(1+\frac{p'}{r^3}\right) \div d\left(1+\frac{p''}{r^3}\right)$ or nearly enough $\frac{d'}{d}\left(1-\frac{p''-p'}{r^3}\right)$ or (say) $\frac{d'}{d}\left(1-\frac{p}{r^3}\right)$. The following tables will show whether p has or has not a considerable value :—

TABLE 30.

Showing values of the ratio $\frac{d'}{d}$, where d' is the double deflection of the magnet N3 in the Electrometer Tower and d is the deflection of the horizontal force magnetograph—both by the deflector magnet E1.

Experiment and date.	r (in feet). 1·5	2·0	3·0
III. 10—11th April 1872 ...	0·77433	0·77700	0·76833
IV. 10—13th September 1873 .	·81046	·81142	·81004
Va. 4th October 1873	·77051	·77096	·77397
VIa. 10th August 1876	·81038	·80308	·79197
VII. 5th February 1877 ..	·81619	·80979	·80224
VIII. 22nd February 1877 ...	·76916	·76200	·75000
IXa. 6th February 1878 ...	·77564	·77039	·75986
X. 11th February 1879 ...	·78631	·77972	·80515
XI. 17th April 1880	·79268	·79264	·79026
Means	0·78952	0·78633	0·78354

TABLE 31.

Showing values of $\frac{d'}{d}$, where d' is the double deflection of the declination magnetograph and d is the deflection of the horizontal force magnetograph—both by the deflector magnet E1.

Experiment and date.	r (in feet). 1·5	2·0	3·0
Vb. 4th October 1873	1·35079	1·35276	1·34932
VIb. 10th August 1876	1·41651	1·41254	1·40510
IXb. 6th February 1878	1·36126	1·36373	1·36917
Means	1·37619	1·37634	1·37453

The numbers d' and d, for the calculation of the ratios in Tables 30 and 31, are taken from Tables 26 and 28 and Table 29*a* respectively.

91. For the reason stated in paragraph 30 the mean numbers only at the foot of Tables 30 and 31 were used for the calculation, in the manner described in paragraph 29, of the constant p in the expression $D=\frac{d'}{d}\left(1-\frac{p}{r^3}\right)$, and with the respective results $p=+\cdot02269$ and $p=+\cdot00344$. It is of little importance whether or not the latter of these numbers be regarded, for when most influential—*i.e.* for the least distance 1·5 foot—it would affect the coefficient by only $\frac{\cdot00344}{(1\cdot5)^3}=\cdot0015$ of itself: and besides in the first case, not only is the value found for p much larger, but the mean numbers show a steady progressive change for the distances 1·5, 2·0 and 3·0, whilst in the second the middle number is greater than either of the extremes: we resolve therefore to apply the correction to the numerators of deflection ratios of the first kind but not to those of the second kind.

92. We shall now assume—in the case of deflections of the magnet N3 after multiplication by the factor $\left(1-\frac{\cdot02269}{r^3}\right)$—that the theoretical ratios are the same for all distances, and the probable error of deflections, both of the declination magnet and of the horizontal force magnet, being the same for all deflections, whether great or small, we shall add the numerators and denominators of the ratios for the several distances together, and take the ratio of the sums $\frac{\Sigma d'}{\Sigma d}$ as the theoretical ratio for a particular set of experiments. It is obvious that there will be some compensation of errors in adding the deflections together, and also that the remaining probable errors of the sums will have less relative effect (that is, effect on the ratio) than the probable errors for the single distances have upon their respective ratios. But if $\Sigma d'$ be first multiplied by a', the value, corrected for torsion of the suspension thread, of a division of the scale in which the auxiliary deflections (d') are observed, and Σd by a, the division will then give the change of force, in terms of the horizontal force as unit, *per* unit arc of change of position of the horizontal force magnet; in other words it will give $\frac{1}{2\sigma}\cdot\frac{dX}{X}$. It is in this manner that the scale-coefficients shown in Table 32 have been obtained from the data that appear alongside of them.

Table 32.

Experiment and date.	Of magnet.	Double deflections. At distance (r). 1·5	2·0	2·5	3·0	$\Sigma d'$	a' Minutes	a' $\frac{arc}{radius}$	$a'\Sigma d'$†	Of horizontal force magnetograph (d) at distance (r). 1·5	2·0	2·5	3·0	Σd	$a\Sigma d$ $a=\cdot00241$	$\frac{a'\Sigma d'}{a\Sigma d}=\frac{1}{dv}\frac{dX}{X}$	Corresponding scale reading s.
1	2	3	4	5	6.	7	8	9	10	11	12	13	14	15	16	17	18
I. 10th August 1870	Declination magnetograph.	38·54	16·44	...	...	54·98	8′·13	·002365	0·13003	31·06	13·00	...	...	44·06	0·10618	1·22454	22·50
II. 1st November 1870	Declination magnetograph.	...	15·95	8·215	...	24·165	8′·13	·002365	·05715	...	12·40	6·40	...	18·80	·04531	‡ 1·26137	32·91
III. 10—11th April 1872	N3.*	20·48	8·80	...	2·61	31·89	14′·38	·004212	·13432	26·72	11·39	...	3·41	41·52	·10006	1·34236	36·65
IV. 10—13th September 1873 ...	N3.	17·48	7·49	...	2·25	27·22	14′·35	·004174	·11362	21·79	9·28	...	2·79	33·86	·08160	1·39241	21·24
V*a*. 4th October 1873	N3.	17·48	7·50	...	2·25	27·23	14′·35	·004174	·11374	22·92	9·78	...	2·92	35·62	·08584	1·32504	36·44
V*b*. 4th October 1873	Declination magnetograph.	30·96	13·23	...	3·94	48·13	8′·13	·002365									
VI*a*. 10th August 1876	N3.	17·01	7·26	3·75	2·16	30·18	14′·30	·004160	·12585	21·20	9·09	4·68	2·74	37·71	·09088	1·38472	22·77
VI*b*. 10th August 1876	Declination magnetograph.	30·03	12·84	6·62	3·85	53·34	8′·13	·002365									
VII. 5th February 1877	N3.	16·97	7·24	3·70	2·14	30·05	14′·31	·004165	·12516	21·00	8·99	4·63	2·68	37·30	·08989	1·39216	20·80
VIII. 22nd February 1877	N3.	16·99	7·26	3·73	2·15	30·13	14′·29	·004155	·12519	22·31	9·58	4·93	2·88	39·70	·09568	1·30838	36·17
IX*a*. 6th February 1878	N3.	16·77	7·14	...	2·11	26·02	14′·30	·004160	·10882	21·84	9·32	...	2·79	33·95	·08182	1·33000	32·48
IX*b*. 6th February 1878	Declination magnetograph.	29·73	12·71	...	3·82	46·26	8′·13	·002365									
X. 11th February 1879	N3.	16·72	7·11	...	2·18	26·01	14′·30	·004160	·10820	21·48	9·17	...	2·72	33·37	·08042	1·34531	29·99
XI. 17th April 1880	N3.	16·50	7·07	...	2·10	25·67	14′·30	·004160	·10679	21·03	8·97	...	2·67	32·67	·07874	1·35618	27·11
XII. 7—8th June 1882	N3.	16·35	6·99	3·62	2·11	29·07	14′·30	·004160	·12093	20·52	8·76	4·49	2·64	36·41	·08775	1·37807	23·33

* The double deflections of magnet N3 are all multiplied by $\left(1-\frac{\cdot02209}{r^5}\right)$ before being entered in this table.

† Where two independent values of $a'\Sigma d'$ are available the mean of the two is adopted for combination with $a\Sigma d$.

‡ The strong horizontal lines in column 17 separate determinations belonging to one undisturbed adjustment of the instrument from those belonging to other undisturbed adjustments.

93. Although an exact knowledge of the inclination of the magnetic axis of the magnet to the magnetic meridian is not requisite for the utilization of equation (8), yet as we shall have to adopt some scale-reading as corresponding approximately to the value 90° of that inclination, and as we have yet to justify the rejection of the last term of equation (3), we may now describe the process by which the absolute position of the magnet was determined. We may remark, however, that the latter consideration is of less importance than it would be for stations of higher magnetic latitude, because at Bombay the range of the regular diurnal variation of declination (dA), expressed in force, is on the average only about half that of the regular diurnal variation of horizontal force.

94. The first aim was to find what the torsion circle reading is when both wires are in the same vertical plane and the north end of the magnet pointing northward. It was found that the torsion circle readings 28° 0′ and 279° 30′* placed the magnet nearly at right angles to the magnetic meridian—the north end pointing westward in the former case and eastward in the latter. In order to allow of a continued vibration of the magnet in these positions the air in the enclosure was pumped out down to a pressure of about 4 inches of mercury. The respective times of vibration were observed and found to be 4″·1695 and 4″·1571, the semi-arc of vibration being always less than one degree and other influences, such as temperature and rate of chronometer, sensibly constant.

95. Now if the equilibrium expressed by equation (1) be forcibly destroyed by momentarily displacing the magnet through an angle Δv, both the new forces brought into action—the excesses of those due to the new position over those due to the undisturbed one—will tend to restore the magnet to its undisturbed position, about which it will oscillate: the ratios of the moments of restitution to the disturbance being $m\,X\,cos\,(A-v)$ and $Wg\frac{aa'}{l}\,cos\,v$ the equation of oscillation will be

$$m\,X\,cos\,(A-v)+Wg\frac{aa'}{l}\,cos\,v=\frac{\pi^2 K}{T^2} \qquad (f)$$

K being the moment of inertia of the vibrating mass and T the time of vibration. Differentiating this and dividing by itself, we obtain

$$\frac{-m\,X\,sin\,(A-v)\,(dA-dv)-Wg\frac{aa'}{l}\,sin\,v\,dv}{m\,X\,cos\,(A-v)+Wg\frac{aa'}{l}\,cos\,v}=-\frac{2dT}{T}$$

$$\frac{\left\{m\,X\,sin\,(A-v)-Wg\frac{aa'}{l}\,sin\,v\right\}dv-m\,X\,sin\,(A-v)\,dA}{m\,X\,cos\,(A-v)+Wg\frac{aa'}{l}\,cos\,v}=-\frac{2dT}{T}$$

but as the coefficient of dv is by equation (1), equal to zero

$$dA=\frac{2dT}{T}\left\{cot\,v+cot\,(A-v)\right\} \qquad (g)$$

For the case under discussion we may take $(A-v)=90°$; $v=\frac{1}{2}(279°\,30'-28°\,0'-180°)=35°\,45'$; whence $dA=-2\frac{\cdot0124}{4\cdot1633}\,cot\,35°\,45'=28'$. Hence the meridian reading must be made 28′ nearer to 279° 30′, for which position the time of vibration is the lesser, than to 28° 0′, that is, it must be 153° 59′†. The reading we have adopted is 154° 0′.‡

96. In the next place the torsion circle readings were made successively 334° and 154°, so as to make the vertical plane containing the two wires and the magnetic meridian coincident—in the one case with the north end of the magnet pointing southward and in the other northward: the partial exhaustion of the enclosure was carried down to a pressure of about 4 inches of mercury as before, and the times of vibration of the magnet were observed (on the 4th and 5th March 1872) to be 2″·9851 and 2″·9567 respectively—the semi-arcs of vibration being again under one degree and the other influences sensibly constant.

* The vernier of the torsion circle moves with the suspension wire, and—looking from above—the readings of the circle increase with a right-handed rotation of the vernier plate. The circle reads to 5′.

† A suspicion having arisen that, owing to a slight knock that it received, the mirror might have changed position between the two experiments, the first one was repeated giving the time of vibration 4·1709, and the meridian reading 2′ greater than the above.

‡ The vibration observations which have yielded this result were made on the 29th February and 4th March 1872. A similar pair of observations made on the 16th June 1870, without exhausting the air from the enclosure of the instrument, and therefore necessarily with a large semi-arc of vibration (about 45° at commencement) gave the result 154° 2′.

97. For these experiments, restoring the coefficient rejected from equation (*e*), equation (*f*) becomes

$$-mX + Wg\frac{aa'}{l}\left(1+\frac{(a-a')^2}{2l^2}\right)=\frac{\pi^2 K}{T'^2} \qquad \text{and} \qquad (h)$$

$$+mX + Wg\frac{aa'}{l}\left(1+\frac{(a-a')^2}{2l^2}\right)=\frac{\pi^2 K}{T^2} \qquad (i)$$

whence, adding and subtracting,

$$mX=\frac{T'^2-T^2}{2T'^2T^2}\pi^2 K; \text{ and } Wg\frac{aa'}{l}\left(1+\frac{(a-a')^2}{2l^2}\right)=\frac{T'^2+T^2}{2T'^2T^2}\pi^2 K, \text{ or}$$

$$Wg\frac{aa'}{l}=\left(1-\frac{(a-a')^2}{2l^2}\right)\frac{T'^2+T^2}{2T'^2T^2}\pi^2 K \qquad (j)$$

We may now insert these values in equation (*e*), and use the latter to find what value v must have in order that $(A-v)$ should be equal to $\frac{\pi}{2}$. The result is

$$Sin\ v=\frac{mX}{Wg\frac{aa'}{l}}\left(1-\frac{a^2+a'^2-2aa'\ cos\ v}{2l^2}\right)=\frac{T'^2-T^2}{T'^2+T^2}\left(1-\frac{aa'(1-cos\ v)}{l^2}\right) \qquad (k)$$

or inserting numerical values

$$=\frac{(5{\cdot}9851)^2-(2{\cdot}9567)^2}{(5{\cdot}9851)^2+(2{\cdot}9567)^2}\left(1-\frac{0{\cdot}20\times 0{\cdot}18\times(1-cos\ 35^\circ\ 45')}{(12{\cdot}96)^2}\right)=\cdot 60765$$

$$v=37^\circ 26' \qquad (l)$$

98. But in the interval between the two vibration observations the torsion circle was turned so as to read 28° 0′ and the scale-reading, at that time, was observed to be 35·69. Hence if S denote the scale-reading that implies that the axis of the magnet is at right angles to the magnetic meridian

$$28^\circ-(154^\circ-90^\circ-37^\circ\ 26')=(35{\cdot}69-S)\times 8'{\cdot}29, \qquad (m)$$

8′·29 being the angular value of a division of the scale, and S=25·56. This value has been adopted for the period March 1872 to June 1882, during which it is believed that—disregarding an accidental knock that the instrument received on the 26th March 1872—the mirror and magnet have retained the same relative position. Judging by the mean scale-readings of the 25th and 27th March, 1872, the accident did, however, increase the scale-reading by about 1·19 scale division or nearly 10′. For the period September 1870 to February 1872, we have adopted an arbitrary value (28·21) of S, but only after ascertaining that any possible error involved in the use of it cannot affect the scale-coefficient, in any case, to the extent of one two-hundredth of itself, that is—to the extent of our general limit of inconsiderable errors.

99. A straight line is marked upon the marble slab of the horizontal force instrument in the *true* direction N 89° 2′ W, as stated in paragraph 6; and by raising the copper damper and placing it against the magnet so as to thrust it a little aside and so prevent it from oscillating, it was possible, by means of a small drawing square, to compare the direction of the line with that of the edge of the magnet when the scale-reading had a particular value. In this way it was found on the 6th March 1872—the day after the last of the vibration experiments—that the edge of the magnet pointed to magnetic west (0° 56′ north of true west) when the scale read 21·55. This differs by 4 divisions or about 33′ from the reading given by the vibration experiments, but as the means of measurement are rough, and the magnetic axis of the magnet may not be parallel to its edge, it is perhaps as nearly coincident as should be expected.

100. The extreme readings on the record of the horizontal force magnetograph for the two periods for which the adopted values of S were 28·21 and 25·56 were 18·83 and 35·20 and 20·41 and 37·86 respectively, giving maximum departures from the position S, or values of $A-v$, of 1° 18′ and 1° 42′ or, in arc, of ·023 and ·030 respectively: that is to say about $\frac{1}{43}$rd and $\frac{1}{33}$rd are the proportions in which, in the extreme cases, the diurnal variation of declination—the average range of which is ·0031 unit of force—is mixed up with the record of variations of horizontal force.

101. Changes of $(A-v)$ due to secular change of A, *i.e.* to secular change of declination, have been insignificant as compared with changes of v, the least absolute annual

mean declination (that of 1870) during the period of record having been N 0° 49′·3 E, and the greatest (that of 1879) N 0° 57′·5 : since 1879 the easterly declination, as well as the horizontal force, has been decreasing.

102. For the future some sacrifice will be made of continuity of the record, or of the extension of records under an undisturbed adjustment of the instrument, in order to keep the limits of the range of scale-readings nearer together, and thus to reduce the extent of the vitiation of the horizontal force registrations by variations of declination ; and the scale-reading that places the axis of the magnet at right angles to the magnetic meridian will be made to lie more nearly midway between the extremes of the contracted range. This will have to be done by altering the inclination of the mirror to the magnet : the middle position of the record on the photographic register is 3·5 inches from the zero side of the sheet of paper ; for the paper is 6 inches wide, and allowing a space of 0·5 inch between the edge and the nearer zero line, another 0·5 inch between the two days' zero lines, and a margin of 0·5 inch at each side of the remaining space to prevent the curves from crossing the nearer zero line or going off the edge of the sheet, there remains a space of 4 inches available for the curve record : in this space the mean position of the lower curve will be 3·25 inches and that of the upper curve 3·75 inches from the zero edge of the sheet, and the range of motion of each curve will be 3·5 inches ; and thus, if the mean positions of the curves be made to correspond to $(A-v)=\frac{\pi}{2}$, by altering the inclination of the mirror till the reading that is now 25·56 becomes 29·8, the greatest positive or negative value of *cot* $(A-v)$ will be ·015, *i.e. cot* 50′.

103. It is a defect in this instrument, as compared with the form of the old horizontal force magnetometer by Grubb, that whereas in the latter provision was made for moving the collimator on the stirrup of the magnet by exactly 90°, there is no similar provision for placing the mirror of the magnetograph first with its normal nearly parallel to the axis of the magnet, and then exactly 90° removed from the first position.

104. The first month for which the photographic registers of the horizontal force magnetograph are complete is that of September 1870, and since the first day of that month the changes of adjustment of the instrument that have been made are the following—

(1) On the 31st October 1870 the torsion circle reading was increased from 24° 15′ to 26° 0′.
(2) On the 15th May 1871 do. do. 26 0 to 28 0.
(3) On the 29th February 1872 a smaller pulley was substituted, and the wires were separated further apart at top.
(4) On the 1st October 1873 the wires were brought closer together at top.
(5) On the 6th February 1877 do. do.
(6) On the 30th June 1882 a smaller pulley was substituted, and the torsion circle reading decreased from 28° 0′ to 356° 10′.

105. Now separating the determinations of $\frac{1}{dv}\frac{dX}{X}$, given in Table 32, that belong to one undisturbed adjustment of the instrument from those that belong to others, we obtain groups as follows : experiments I and II each by themselves ; and experiments III and IV, V to VII, and VIII to XI forming three groups. From equation (6) we observe that the more nearly the adopted value of S makes $v_o = A-\frac{\pi}{2}$ the more nearly will *cot* v_o be equal to $\frac{1}{dv}\frac{d(mX)_o}{(mX)_o}$; and, at this point, we may notice that as m has been practically constant during each set of deflection experiments, the values of $\frac{1}{dv}\frac{dX}{X}$ found in Table 32, are applicable in equation (9) in lieu of $\frac{1}{dv}\frac{d(mX)}{mX}$: indeed, as independent investigations of the effects of temperature and lapse of time upon the records of the instrument will have to be made, we may, from this time, drop the m altogether and write $\frac{dX}{X}$ and $\frac{dX_o}{X_o}$ for $\frac{d(mX)}{mX}$ and $\frac{d(mX)_o}{(mX)_o}$. Considering then appropriate values of s and S and of $\frac{1}{dv}\frac{dX}{X}$ for each experiment of a particular group, together with equation (9), we have determined a mean value for that group of *cot* v_o by a method of successive approximation. First, we have taken *cot* v_o to be the mean of all the values in the group of $\frac{1}{dv}\frac{dX}{X}$, and inserting this value in equation (9), have found first values

of $\frac{1}{dv}\frac{dX_o}{X_o}$; secondly, we have taken—as a second approximation—the mean of all the first values of $\frac{1}{dv}\frac{dX_o}{X_o}$, and—inserting this in the equation—have found second values of $\frac{1}{dv}\frac{dX_o}{X_o}$; thirdly, we have taken—as a third approximation—the mean of all the second values of $\frac{1}{dv}\frac{dX_o}{X_o}$, and—inserting this in the equation—have found third values of $\frac{1}{dv}\frac{dX_o}{X_o}$; and, fourthly, the mean of these last has been adopted as the final value both of $\frac{1}{dv}\frac{dX_o}{X_o}$ and of $cot\, v_o$. Doubtless we should have obtained nearly the same results by solving the quadratic equation for each experiment separately and averaging the roots, but the process described is simpler to work, and it shows, at each step, the extent to which the numbers of a group are amenable—as a group—to the law assumed by the equation. An exposition of these calculations appears in Table 33.

TABLE 33.

Experiment and date.	$\frac{1}{dv}\frac{dX}{X}$ (observed).	S.	$s-S$*	Third values of $\frac{1}{dv}\frac{dX_o}{X_o}$	Calculated final value of $\frac{1}{dv}\frac{dX_o}{X_o}$ or $cot\, v_o$.	$\frac{a}{dv}\frac{dX_o}{X_o}$	$a^2\, cot^2\, v_o$.
1	2	3	4	5	6	7	8
I. 10th August 1870 ...	1·22454	19·94	...	...	.....	...	...
II. 1st November 1870 ...	1·26137	32·91	...	...	.....	...	...
III. 10—11th April 1872 ...	1·34236	36·65	+11·09	1·393481	1·382989	·0033330	·000011110
IV. 10th to 13th Sept. 1873.	1·39241	21·24	− 4·32	1·372497			
V. 4th October 1873 ...	1·32504	36·44	+10·88	1·374423	1·372345	·0033074	·000010939
VI. 10th August 1876 ...	1·38472	22·77	− 2·79	1·372056			
VII. 5th February 1877 ...	1·39216	20·80	− 4·76	1·370556			
VIII. 22nd February 1877 ...	1·30838	36·17	+10·61	1·355765	1·361216	·0032805	·000010762
IX. 6th February 1878 ...	1·33000	32·48	+ 6·92	1·360905			
X. 11th February 1879 ...	1·34531	29·99	+ 4·43	1·365094			
XI. 17th April 1880 ...	1·35618	27·11	+ 1·55	1·363102			
XII.† 7—8th June 1882 ...	1·37807	23·33	− 2·23	...	.....	...	...

106. From the nearness of agreement of the separate third values of $\frac{1}{dv}\frac{dX_o}{X_o}$, shown in column 5, we may form an estimate of the probable error of a single determination of the scale-coefficient; roughly speaking the average differences from the mean (regardless of signs) are for experiments III and IV about $\frac{1}{140}$th, for experiments V to VII about $\frac{1}{1000}$th, and for experiments VIII to XI about $\frac{1}{470}$th of the whole coefficient.

107. Multiplying equation (9) right through by Xa it becomes

$$Xa\,\frac{1}{dv}\frac{dX}{X} = Xa\,\frac{1}{dv}\frac{dX_o}{X_o} - Xa^2\, cot^2\, v_o\,(s-S) \qquad (n)$$

which expresses the scale-coefficient in terms of the unit of force. Referring to columns 7 and 8 of Table 33 for the coefficients $\frac{a}{dv}\frac{dX_o}{X_o}$ and $a^2\, cot^2\, v_o$, and inserting in this equation the monthly mean values of s and X, we obtain monthly‡ values of the scale-coefficient as shown in the following table.

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* For experiments I and II S has the value 28·21, and for the rest 25·56.

† As the first value of $\frac{1}{dv}\frac{dX_o}{X_o}$ given by this is within a two-hundredth of the final value of it given by the preceding four experiments, the latter value has been adopted, without change, in the calculation of monthly values of the scale-coefficients for later months up to June 1882.

‡ See footnote to paragraph 67.

Table 34.

Constants.	Month.			X. ‡	a.	$X\frac{a}{\nu}\frac{dX}{da}$ (calculated) $=\frac{dX}{dt}$.	$\frac{dX}{dt}$ †
$\frac{a}{\nu}\frac{d\nu}{da}=.0033330$; $a^3\cos^2\nu_0=.0000011110$.	February (24th to 29th)	1872.		3·7218	35·65*	·01199	·04144
	March	...	,,	3·7220	36·66*	·01195	·04130
	April	...	,,	3·7222	36·12	·01197	·04138
	May	...	,,	3·7223	34·85	·01202	·04156
	June	...	,,	3·7225	33·28	·01209	·04179
	July	...	,,	3·7227	31·91	·01215	·04199
	August	...	,,	3·7229	30·72	·01220	·04216
	September	...	,,	3·7230	29·88	·01223	·04228
	October	...	,,	3·7232	28·82	·01227	·04244
	November	...	,,	3·7234	28·18	·01230	·04253
	December	...	,,	3·7235	27·50	·01233	·04263
	January	...	1873.	3·7237	26·62	·01237	·04276
	February	...	,,	3·7239	26·18	·01239	·04282
	March	...	,,	3·7241	25·52	·01241	·04292
	April	...	,,	3·7242	24·87	·01244	·04301
	May	...	,,	3·7244	24·09	·01247	·04312
	June	...	,,	3·7246	23·12	·01251	·04327
	July	...	,,	3·7248	22·35	·01255	·04338
	August	...	,,	3·7249	21·69	·01258	·04347
	September	...	,,	3·7251	21·11	·01260	·04356
$\frac{a}{\nu}\frac{d\nu}{da}=.0033074$; $a^3\cos^2\nu_0=.0000010939$.	October	...	1873.	3·7253	36·03*	·01189	·04112
	November	...	,,	3·7255	35·51*	·01192	·04120
	December	...	,,	3·7256	35·03	·01194	·04126
	January	...	1874.	3·7258	34·52	·01196	·04134
	February	...	,,	3·7260	34·09	·01198	·04140
	March	...	,,	3·7262	33·84	·01199	·04144
	April	...	,,	3·7263	33·43	·01200	·04150
	May	...	,,	3·7265	33·12	·01202	·04154
	June	...	,,	3·7267	32·61	·01204	·04162
	July	...	,,	3·7269	32·08	·01206	·04170
	August	...	,,	3·7270	31·60	·01208	·04176
	September	...	,,	3·7272	31·11	·01210	·04184
	October	...	,,	3·7274	30·59	·01212	·04191
	November	...	,,	3·7276	30·27	·01214	·04196
	December	...	,,	3·7277	29·94	·01215	·04201
	January	...	1875.	3·7279	29·69*	·01216	·04204
	February	...	,,	3·7281	29·32*	·01218	·04210
	March	...	,,	3·7282	28·82*	·01220	·04217
	April	...	,,	3·7284	28·70*	·01220	·04219
	May	...	,,	3·7286	28·24*	·01222	·04226
	June	...	,,	3·7288	27·78*	·01224	·04232
	July	...	,,	3·7289	27·20*	·01227	·04241
	August	...	,,	3·7291	26·76*	·01228	·04247
	September	...	,,	3·7293	26·23*	·01231	·04255
	October	...	,,	3·7294	25·87*	·01232	·04260
	November	...	,,	3·7296	25·53*	·01234	·04265
	December	...	,,	3·7298	25·21*	·01235	·04270
	January	...	1876.	3·7299	24·92	·01236	·04274
	February	...	,,	3·7301	24·57	·01238	·04279
	March	...	,,	3·7303	24·36	·01239	·04282
	April	...	,,	3·7305	24·10	·01240	·04286
	May	...	,,	3·7306	23·74	·01241	·04291
	June	...	,,	3·7308	23·36	·01243	·04297
	July	...	,,	3·7310	23·01	·01244	·04302
	August	...	,,	3·7312	22·63	·01246	·04308
	September	...	,,	3·7313	22·23	·01248	·04313
	October	...	,,	3·7315	21·88	·01249	·04319
	November	...	,,	3·7317	21·59	·01250	·04323
	December	...	,,	3·7318	21·28	·01252	·04327
	January	...	1877.	3·7320	21·01	·01253	·04331
	February (1st to 5th)		,,	3·7322	20·91*	·01253	·04333
$\frac{a}{\nu}\frac{d\nu}{da}=.0032805$; $a^3\cos^2\nu_0=.0000010762$.	February (6th to 28th)		1877.	3·7322	36·30*	·01181	·04084
	March	...	,,	3·7324	35·99	·01183	·04088
	April	...	,,	3·7325	35·69	·01184	·04092
	May	...	,,	3·7327	35·25	·01186	·04099
	June	...	,,	3·7329	34·90	·01187	·04104
	July	...	,,	3·7331	34·60	·01188	·04108
	August	...	,,	3·7332	34·22	·01190	·04114
	September	...	,,	3·7334	33·86	·01191	·04119
	October	...	,,	3·7336	33·51	·01193	·04124
	November	...	,,	3·7338	33·13	·01194	·04129
	December	...	,,	3·7339	32·91	·01195	·04133
	January	...	1878.	3·7341	32·66	·01196	·04136
	February	...	,,	3·7343	32·46	·01197	·04139
	March	...	,,	3·7345	32·29	·01198	·04142
	April	...	,,	3·7346	32·03	·01199	·04146
	May	...	,,	3·7348	31·73	·01200	·04150
	June	...	,,	3·7350	31·37	·01202	·04155
	July	...	,,	3·7352	31·21	·01203	·04158
	August	...	,,	3·7353	30·98	·01204	·04161
	September	...	,,	3·7355	30·68	·01205	·04165
	October	...	,,	3·7357	30·46	·01206	·04169
	November	...	,,	3·7359	30·23	·01207	·04172
	December	...	,,	3·7360	29·97	·01208	·04176
	January	...	1879.	3·7362	29·81	·01209	·04178
	February	...	,,	3·7364	29·64*	·01209	·04181
	March	...	,,	3·7365	29·44	·01210	·04184
	April	...	,,	3·7367	29·30	·01211	·04186
	May	...	,,	3·7369	29·10	·01212	·04189
	June	...	,,	3·7371	28·89	·01213	·04192
	July	...	,,	3·7372	28·71	·01213	·04195
	August	...	,,	3·7374	28·49	·01214	·04198
	September	...	,,	3·7376	28·24	·01215	·04202
	October	...	,,	3·7377	28·08	·01216	·04204
	November	...	,,	3·7379	27·91	·01217	·04207
	December	...	,,	3·7381	27·72	·01218	·04209
	January	...	1880.	3·7383	27·56*	·01218	·04212
	February	...	,,	3·7384	27·38	·01219	·04214
	March	...	,,	3·7386	27·17	·01220	·04218
	April	...	,,	3·7388	27·07	·01220	·04219
	May	...	,,	3·7389	26·83	·01221	·04223
	June	...	,,	3·7391	26·78	·01222	·04224
	July	...	,,	3·7393	26·66	·01222	·04226
	August	...	,,	3·7395	26·23	·01224	·04232
	September	...	,,	3·7396	26·20	·01224	·04232
	October	...	,,	3·7398	26·06	·01225	·04234
	November	...	,,	3·7400	25·87	·01226	·04237
	December	...	,,	3·7401	25·78	·01226	·04239
	January	...	1881.	3·7403	25·68*	·01227	·04240
	February	...	,,	3·7405	25·42*	·01228	·04244
	March	...	,,	3·7407	25·45	·01228	·04244
	April	...	,,	3·7408	25·34	·01228	·04246
	May	...	,,	3·7410	25·23	·01229	·04247
	June	...	,,	3·7412	25·09	·01229	·04250
	July	...	,,	3·7414	24·96	·01230	·04252
	August	...	,,	3·7415	24·85	·01230	·04253
	September	...	,,	3·7417	24·54	·01232	·04258
	October	...	,,	3·7419	24·46	·01232	·04259
	November	...	,,	3·7421	24·24	·01233	·04262
	December	...	,,	3·7422	24·16	·01233	·04264
	January	...	1882.	3·7350	24·07	·01231	·04256
	February	...	,,	3·7350	23·94	·01232	·04258
	March	...	,,	3·7349	23·90	·01232	·04259
	April	...	,,	3·7349	23·51	·01233	·04264
	May	...	,,	3·7348	23·43	·01234	·04265
	June (1st to 28th)		,,	3·7348	23·36*	·01234	·04266

* Approximate means.

† The last column gives the coefficients for variations, in inches, of ordinates of the photographic curves.

‡ The monthly values of X from October 1870 to December 1881, are calculated by the formula

$$X = 6{\cdot}46108\ (8{\cdot}0658 + {\cdot}00457),$$

T being the time in years after the 1st October 1870. (See Philosophical Transactions, vol. 166, page 90, where the formula is derived from the absolute determinations of the years 1867 to 1873). After 1881 the mean of the absolute determinations of the preceding year is corrected for secular change at the rate which held between the two preceding years.

108. For the months September 1870 to February 1872 we must take account of the changes of torsion circle reading made on the 31st October 1870 and on the 15th May 1871. Taking the value of $\frac{1}{dv}\frac{dX}{X}$ (1·26137) given by experiment II (that of November 1, 1870) as equal to $\frac{1}{dv}\frac{dX}{X}-a\ cot^2 v_0$ (32·91 −28·21) we find v_0 to be 38° 0′, at which it remained from November 1870 to May 15, 1871: to this adding 1° 45′ the decrease of torsion introduced on the 31st October 1870 we have 39° 45′ as the value of v_0 for September and October 1870; and deducting 2° 0′, the decrease made on the 15th May 1871, we have further 36° 0′ for the v_0 of May 15, 1871 to February 1872. With these data and making $\frac{1}{dv}\frac{dX}{X}=cot\ v_0$, we obtain the following monthly values of the scale-coefficients which have been adopted for the period in question :—

TABLE 35.

Constants.	Month.		X.	s.	$X\frac{a}{dv}\frac{dX}{X}$ (calculated) $=\frac{dX}{ds}$	$\frac{dX}{di}$ †
$\frac{a}{dv}\frac{dX}{X}=\cdot0028977$; $a^2cot^2v_0=\cdot000008397$.	September	1870...	3·7189	23·81*	·01091	·03773
	October	„ ...	3·7191	20·91*	·01100	·03805
$\frac{a}{dv}\frac{dX}{X}=\cdot0030847$; $a^2cot^2v_0=\cdot000009515$.	November	1870...	3·7193	31·74*	·01135	·03923
	December	„ ...	3·7194	29·42	·01143	·03952
	January	1871...	3·7196	27·51	·01150	·03975
	February	„ ...	3·7198	25·80	·01156	·03996
	March	„ ...	3·7199	24·26*	·01161	·04015
	April	„ ...	3·7201	22·44*	·01168	·04038
	May (1st to 15th)	„ ...	3·7203	20·95*	·01173	·04056
$\frac{a}{dv}\frac{X}{dX}=\cdot0033171$; $a^2\ cot^2 v_0=\cdot000011003$.	May (16th to 31st)	1871...	3·7203	34·25*	·01209	·04181
	June	„ ...	3·7205	32·63*	·01216	·04204
	July	„ ...	3·7206	29·89*	·01227	·04243
	August	„ ...	3·7208	28·17*	·01234	·04267
	September	„ ...	3·7210	26·67*	·01241	·04289
	October	„ ...	3·7211	25·13*	·01247	·04311
	November	„ ...	3·7213	23·59*	·01253	·04333
	December	„ ...	3·7215	22·51*	·01258	·04348
	January	1872...	3·7217	21·06*	·01264	·04369
	Feby. (1st to 20th)	„ ...	3·7218	19·99*	·01268	·04384

* Approximate means.
† The last column gives the coefficients for variations, in inches, of ordinates of the photographic curves.

109. Periods during which the air in the enclosure of the horizontal force magnetograph was under artificial pressure were as follows :—

Beginning of Period.	Pressure.	End of Period.	Pressure.
	Inches of Mercury.		Inches of Mercury.
April 1, 1872 ...	4·61	April 9, 1872 ...	4·61
April 9, 1872 ...	2·78	October 1, 1873 ...	2·61
May 27, 1874 ...	2·02	November 17, 1874 ...	7·23
November 17, 1874 ...	3·12	January 11, 1875 ...	7·50
January 11, 1875 ...	1·44	March 9, 1875 ...	7·40
March 9, 1875 ...	2·10	February 6, 1877 ...	7·04
January 22, 1880 ...	2·25	May 24, 1880 ...	7·48

Temperature-coefficient of the Horizontal Force Magnetograph.

110. The same experiments of heating and cooling the magnetograph room that have been described, in paragraph 73, in seeking the temperature-coefficient of the vertical force magnetograph, were effective in heating and cooling the horizontal force magnetograph. Practically simultaneous readings were taken of the scale of the horizontal force magnetograph and of the thermometer (Fahrenheit) placed in the enclosure of that instrument, with the results shown, for each of the five experiments, in Table 36:—

Table 36.

Date.	Colaba mean time.	Horizontal Force Magnetograph. Scale-reading. Observed.	Corrected for change of H. F.	Ther-mometer.	Date.	Colaba mean time.	Horizontal Force Magnetograph. Scale-reading. Observed.	Corrected for change of H. F.	Ther-mometer.	Date.	Colaba mean time.	Horizontal Force Magnetograph. Scale-reading. Observed.	Corrected for change of H. F.	Ther-mometer.
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
First set of Experiments.														
15th February 1879.	h. m.				15th February 1879.	h. m.				15th to 17th February 1879.	h. m.			
	6 19	29·65	29·65	86·8		17 36	29·30	29·24	102·0		23 1	29·37	29·43	98·8
	10 19a	29·62	29·43	94·9		17 51	29·29	29·25	102·0		23 36d	29·42	29·47	96·8
	13 8	29·58	29·35	97·4		18 6	29·28	29·25	101·9		0 6	29·46	29·50	95·8
	14 10	29·52	29·34	98·1		18 21	29·24	29·22	101·9		0 36	29·37	29·43	95·0
	14 36	29·51	29·29	98·4		18 36	29·22	29·22	101·9		1 6	29·36	29·43	94·5
	14 51	29·51	29·29	98·7		18 51	29·21	29·22	102·0		1 36	29·34	29·42	93·9
	15 6	29·49	29·27	98·7		19 6	29·20	29·22	102·0		2 6	29·40	29·42	93·4
	15 21	29·49	29·28	98·6		19 21	29·20	29·22	102·0		2 38e	29·41	29·45	92·8
	15 36	29·47	29·30	98·7		19 36	29·19	29·22	102·0		4 6	29·43	29·44	92·3
	15 51	29·44	29·29	99·0		19 51	29·18	29·22	102·0		5 6	29·43	29·41	92·1
	16 6	29·40	29·27	99·2		20 6	29·12	29·19	102·0		6 19	29·50	29·45	91·6
	16 21	29·39	29·27	99·6		20 21	29·12	29·20	102·0		10 19	29·60	29·46	90·8
	16 36b	29·39	29·29	100·0		20 36	29·11	29·21	102·0		14 19	29·50	29·47	89·5
	16 51	29·38	29·30	100·4		20 51	29·22	29·22	102·0		16 19	29·45	29·46	89·1
	17 6	29·38	29·31	100·8		21 6	29·25	29·20	102·0		22 19	29·49	29·51	88·3
	17 21	29·34	29·27	101·2		21 21c	29·19	29·19	101·9		6 19	29·66	29·52	87·7
Second set of Experiments.														
25th and 26th January 1880.	16 19	27·48	27·37	84·1	26th January 1880.	13 21	27·17	27·01	100·0	26th and 27th January 1880.	18 8	27·08	27·01	97·0
	22 19f	27·38	27·49	83·9		13 36	27·13	26·99	101·1		18 36	27·11	27·05	96·0
	4 38	27·47	27·52	82·8		13 51	27·11	26·98	101·3		19 6	27·12	27·09	95·0
	5 10	27·48	27·55	82·7		14 8h	27·10	26·96	101·5		19 36	27·12	27·11	94·4
	5 38	27·47	27·54	82·7		14 21	27·10	26·95	101·9		20 8	27·15	27·15	93·7
	6 10	27·48	27·53	82·7		14 36	27·06	26·93	102·1		20 36	27·14	27·15	93·1
	6 38	27·50	27·52	82·7		14 51	27·03	26·90	102·3		21 36	27·17	27·21	91·9
	7 8j	27·51	27·53	82·9		15 6	27·02	26·90	102·3		22 36	27·18	27·24	91·2
	10 19	27·32	27·20	94·3		15 21	27·01	26·91	102·2		0 36	27·20	27·28	90·0
	11 38	27·30	27·14	96·0		15 36	26·99	26·90	102·5		2 36	27·23	27·24	89·1
	11 53	27·29	27·11	96·2		15 51	26·98	26·90	102·4		4 36	27·27	27·28	88·0
	12 10	27·29	27·13	96·6		16 36i	26·98	26·87	102·0		6 36	27·30	27·29	87·5
	12 21	27·27	27·08	97·2		17 6	26·99	26·89	100·2		8 36	27·39	27·34	87·1
	12 36	27·25	27·07	97·6		17 21	27·00	26·92	99·2		10 36	27·40	27·31	87·2
	12 51	27·23	27·03	97·8		17 36	27·03	26·96	98·2		11 36	27·41	27·25	87·1
	13 6	27·20	27·03	98·8		17 51	27·07	26·98	97·9		...	...	...	...
Third set of Experiments.														
30th January 1880.	6 19	27·29	27·33	85·5	30th January 1880.	12 51	27·32	27·06	93·1	30th and 31st Janv. 1880.	18 36	27·21	27·16	90·0
	10 19	27·42	27·29	85·5		13 6	27·33	27·04	93·2		20 36	27·20	27·20	89·6
	11 10j	27·40	27·17	89·9		13 21	27·31	27·03	93·3		22 36k	27·28	27·24	88·1
	11 21	27·39	27·15	90·9		13 36	27·30	27·04	93·3		0 36	27·30	27·23	87·2
	11 36	27·38	27·13	91·6		13 51	27·29	27·05	93·1		2 36	27·30	27·25	87·0
	11 51	27·39	27·13	92·0		14 8	27·26	27·03	92·7		4 36	27·41	27·29	86·5
	12 8	27·34	27·08	92·2		14 36	27·28	27·03	92·3		6 36	27·49	27·32	85·7
	12 21	27·34	27·09	92·5		15 36	27·26	27·08	91·3		8 36	27·55	27·33	85·4
	12 36	27·33	27·07	92·7		16 36	27·26	27·11	90·7		10 36	27·59	27·31	85·4

a. Fire made in the magnetograph room at 7h. 2m.
b. No more coals added after this time.
c. Removed the fire away between 21h. 30m. and 22h. 15m. and opened the doors and ventilators.
d. Fire made in the upper stove at 23h.
e. Removed the fire away from upper stove at 2½h. on the 16th.
f. Fire made in the upper stove at 18h. on the 25th and kept burning till 7h. on the 26th.
g. Reading just taken when the fire was brought into the room.
h. No more coals added after this time.
i. Fire removed away at about 16 hours, and doors and ventilators opened.
j. Reading taken after the fire had been lighted for some time.
k. Doors and ventilators opened about 21½h.

TABLE 36—*continued.*

Date.	Colaba mean time.	Horizontal Force Magnetograph. Scale-reading. Observed.	Corrected for change of H. F.	Thermometer.
1	2	3	4	5
Fourth set of Experiments.				
7th and 8th January 1881.	h. m.			
	10 38	25·72	25·74	85·7
	14 38	25·72	25·66	85·8
	16 38a	25·71	25·68	85·4
	22 38	25·71	25·82	85·0
	5 38	25·77	25·85	84·6
	6 38	25·79	25·84	84·5
	7 38	25·72	25·81	84·5
	10 38	25·71	25·80	84·5
	11 38	25·73	25·75	84·6
	11 23	25·73	25·72	85·0
	11 38	25·75	25·72	85·7
	11 53	25·76	25·71	86·5
	12 8	25·76	25·70	87·0
	12 23	25·77	25·69	87·8
	12 38	25·73	25·65	88·5
	12 53	25·72	25·62	89·0
	13 8	25·70	25·62	89·7
	13 23	25·69	25·62	90·0
	13 38	25·68	25·61	90·4
	13 53	25·65	25·59	90·7
	14 8	25·64	25·59	91·0
	14 23	25·62	25·57	91·2
	14 38	25·62	25·55	91·6
	14 53	25·61	25·54	92·0
	15 8	25·60	25·53	92·4
	15 23	25·58	25·54	92·8
	15 38	25·55	25·54	93·0
	15 53	25·54	25·55	93·3
	16 8	25·52	25·53	93·6
8th and 9th January 1881.	h. m.			
	16 23	25·50	25·52	94·3
	16 38	25·50	25·53	94·6
	16 53	25·50	25·52	94·8
	17 8	25·50	25·51	95·0
	17 23	25·50	25·50	95·3
	17 38	25·48	25·50	95·7
	17 53	25·47	25·49	96·0
	18 8	25·46	25·48	96·4
	18 23	25·44	25·47	96·6
	18 38	25·42	25·45	96·6
	18 53	25·41	25·44	96·8
	19 8	25·40	25·45	96·8
	19 23	25·38	25·45	97·0
	19 38	25·38	25·45	97·2
	19 53	25·38	25·46	97·3
	20 8	25·38	25·46	97·3
	20 23	25·36	25·46	97·7
	20 38	25·33	25·44	98·1
	20 53	25·32	25·43	98·4
	21 8	25·32	25·43	98·6
	21 23	25·31	25·42	98·7
	21 38	25·31	25·42	98·8
	21 53	25·30	25·42	98·8
	22 8	25·31	25·44	98·9
	23 8c	25·37	25·44	98·8
	0 8	25·39	25·52	98·0
	1 8	25·41	25·52	97·1
	2 8	25·47	25·55	96·0
	3 8	25·44	25·57	95·1
9th and 10th January 1881.	h. m.			
	4 8	25·48	25·54	94·6
	5 8	25·50	25·56	94·3
	6 8	25·53	25·57	93·4
	7 8	25·61	25·61	92·9
	8 8	25·67	25·65	92·7
	9 8	25·68	25·67	92·6
	10 8	25·70	25·63	92·6
	11 8	25·77	25·65	92·3
	11 38	25·78	25·64	92·2
	12 38	25·78	25·63	92·1
	13 38d	25·73	25·62	91·3
	14 38	25·63	25·57	90·3
	15 38	25·62	25·60	89·8
	16 38	25·63	25·62	89·6
	17 38e	25·65	25·65	89·2
	18 38	25·70	25·68	88·7
	19 38	25·71	25·71	88·5
	20 38	25·73	25·73	88·2
	21 38	25·72	25·72	87·9
	22 38	25·72	25·68	87·5
	0 38	25·68	25·71	87·2
	3 38	25·69	25·78	86·4
	6 38	25·71	25·74	85·9
	10 38	25·94	25·74	85·9
	14 38f	25·88	25·66	86·0
	16 38	25·81	25·69	85·8
	18 38g	25·74	25·69	85·8
Single cooling Experiment.				
31st January and 1st February 1881.	22 38h	23·58	...	84·9
	4 38	24·50	...	84·0
	5 38	24·61	...	84·0
1st Feby. 1881.	6 38	24·66	...	84·0
	7 38	24·79	...	84·0
	8 38	24·71	...	84·0
1st Feby. 1881.	9 38	24·90	...	84·2
	10 38i	25·10	...	84·5
	...	...	...	...
Fifth set of Experiments.				
24th February 1881.	6 19j	25·46	25·59	84·9
	8 8	25·61	25·56	84·9
	10 19	25·75	25·55	85·1
	14 19	25·50	25·48	85·1
	16 19	25·43	25·49	85·2
	18 23k	25·41	25·48	85·7
	18 38	25·40	25·48	86·1
	18 53	25·40	25·48	86·8
	19 8	25·38	25·49	87·1
	19 23	25·39	25·48	87·3
	19 38	25·38	25·47	88·0
	19 53	25·36	25·45	88·6
	20 8	25·34	25·44	89·1
	20 23	25·32	25·41	89·7
	20 38	25·31	25·41	90·2
	20 53	25·30	25·41	90·6
	21 8	25·29	25·42	90·8
	21 23	25·27	25·39	91·0
	21 38	25·22	25·36	91·5
	21 53	25·18	25·34	91·6
	22 8	25·17	25·34	91·8
	22 23	25·17	25·33	92·0
24th and 25th February 1881.	22 38	25·17	25·33	92·2
	22 53	25·18	25·34	92·5
	23 8	25·20	25·35	92·7
	23 23	25·20	25·33	93·1
	23 38	25·20	25·33	93·3
	23 53	25·20	25·33	93·5
	0 8	25·19	25·32	93·8
	0 23	25·18	25·32	93·9
	0 38	25·18	25·31	94·4
	0 53	25·18	25·30	94·7
	1 8	25·18	25·29	95·0
	1 23	25·17	25·28	95·1
	1 38	25·17	25·29	95·2
	1 53	25·17	25·28	95·2
	2 8	25·17	25·28	95·2
	2 23	25·17	25·28	95·3
	2 38	25·17	25·28	95·3
	2 53	25·23	25·32	94·4
	3 8	25·22	25·31	93·5
	3 53	25·27	25·36	93·0
	4 8	25·29	25·38	92·5
	4 38	25·30	25·40	92·1
25th February 1881.	4 53	25·24	25·35	91·6
	5 8	25·30	25·40	91·5
	5 23	25·32	25·42	91·3
	5 38	25·31	25·40	91·1
	5 53	25·34	25·42	90·9
	6 8	25·33	25·40	90·7
	6 23	25·36	25·41	90·6
	6 38	25·40	25·43	90·5
	6 53	25·45	25·47	90·2
	7 8	25·45	25·45	90·0
	7 23	25·46	25·45	89·9
	7 38	25·46	25·43	89·7
	8 38	25·60	25·51	89·4
	9 38	25·64	25·49	88·8
	10 19	25·62	25·46	88·9
	12 38m	25·63	25·44	88·4
	14 19	25·40	25·43	88·0
	16 19	25·37	25·43	87·7
	18 38	25·41	25·46	87·1
	20 38	25·38	25·47	87·0
	...	...	...	...
	...	...	...	...

a. Fire made in the upper stove at about 14½h. and ventilators and doors opened.
b. Fire made in the magnetograph room at 10h. 48m.
c. No more coals added after 22½ hours.
d. Doors and ventilators opened at 13h. 14m.
e. Vigorous fire made in the upper stove at 17h. 18m.
f. Fire taken away from the upper stove at 16h. 50m.
g. Doors closed at 19h.
h. Cooling commenced from 18h. 1m. when the doors and ventilators were opened and a fire kindled in the upper stove.
i. Cooling operation stopped, doors closed and fire in upper stove put out at 12h. 45m.
j. Doors and ventilators left open and fire kindled in upper stove at 18h.
k. Heating commenced at 18h. 8m.
l. At 3h. put out fire in the lower stove and kindled in upper one, and doors and ventilators left open.
m. Fire put out in the upper stove at 11h. 0m. on 26th, doors closed at 7h. 6m. on 27th.

The curves of Figs. 63 to 67 are constructed from the numbers in this table, taking the temperatures as abscissæ, the scale-readings as ordinates, and marking the times along the course of the curves. Figs. 68 to 72 are identical with 63 to 67 except that, for them, the scale-readings, shown in column 4 of Table 36, are corrected, in the case of each curve, to a constant value of the horizontal force; this was done by means of nearly simultaneous readings* of Grubb's horizontal force magnetometer, on the assumption that the changes of force were the same in the magnetograph room as in the magnetic observatory; it is evident, at a glance, that some of the irregularity of Figs. 63 to 67 has been removed by the operation, and the corrected scale-readings will therefore be used, in preference to the uncorrected, in the steps now to be taken.

111. The remarks made in paragraph 82 apply in some small degree in this case also, and here too, we resolved to base the reductions on such observations only as were made during times when the temperature was steady. The periods selected as comprising times of nearly uniform higher temperature and times of nearly uniform lower temperature, and the average scale-readings (corrected) and average temperatures for these periods are shown in Table 37, as are also the scale-reading differences and temperature differences of the intervals between the respective periods (the latter being always taken with the positive sign), the sums of these differences, and the quotients $\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$.

TABLE 37.

Period.			Horizontal Force Magnetograph.				
Month.	Beginning	End.	Scale-reading corrected to a constant value of the horizontal force.	Differences.	Thermometer.	Differences.	$\frac{\Delta s}{\Delta t}$.
1	2	3	4	5	6	7	8
February 1879.	d. h. m.	d. h. m.					
	15 6 19	15 6 19	29·65		86·8		
				= 0·43		+ 15·2	
	15 17 38	15 21 21	29·28		102·0		
				= 0·28		+ 14·3	
	17 6 19	17 10 19	29·50		87·7		
Sums and quotient			.....	− 0·71	...	+ 29·5	= ·024
Corresponding means			29·39	...	94·6	...	.....
Temperature coefficient $= \frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0121 \times (-·024) = -·00029.$							
January 1880.	d. h. m.	d. h. m.					
	26 7 8	26 7 8	27·53		82·9		
				− 0·63		+ 19·4	
	26 14 38	26 16 38	26·90		102·3		
				− 0·40		+ 15·1	
	27 6 38	27 11 38	27·30		87·2		
Sums and quotient			.....	− 1·03	...	+ 34·5	− ·030
Corresponding means			27·15	...	93·6	...	.....
Temperature coefficient $= \frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0122 \times (-·030) = -·00037.$							

* These readings were taken 4 minutes before those of the horizontal force magnetograph.

COLABA HORIZONTAL FORCE MAGNETOGRAPH.

HEATING AND COOLING EXPERIMENTS.

Plate VI.

UNCORRECTED. | CORRECTED.

FOR CHANGE OF HORIZONTAL FORCE.

TEMPERATURE.

SCALE DIVISIONS.

29·50 / 29·20

FEBRUARY 15-17, 1879.

Fig. 63.

Fig. 63.

27·40 / 27·00

JANUARY 25-27, 1880.

Fig. 64.

Fig. 64.

27·50 / 27·20

JANUARY 30-31, 1880.

Fig. 65.

Fig. 70.

25·80 / 25·40

JANUARY 7-10, 1881.

Fig. 66.

Fig. 71.

25·50 / 25·10

FEBRUARY 24-25, 1881.

Fig. 67.

Fig. 72.

THE NUMBERS PLACED ALONG THE COURSE OF THE CURVES ARE HOURS OF THE DAY.

TABLE 37—*continued.*

PERIOD.			HORIZONTAL FORCE MAGNETOGRAPH.				
Month.	Beginning.	End.	Scale-reading corrected to a constant value of the horizontal force.	Differences.	Thermometer.	Differences.	$\frac{\Delta s}{\Delta t}$.
1	2	3	4	5	6	7	8
January 1880.	d. h. m.	d. h. m.					
	30 6 19	30 10 19	27·31		85·5		
				−0·26		+7·3	
	30 12 8	30 14 36	27·05		92·8		
	30 15 36	30 18 36	27·12	−0·27	90·7	+7·3	
	31 6 36	31 10 36	27·32		85·5		
Sums and quotient ...			.....	−0·53	...	+14·6	−·036
Corresponding means ...			27·18	...	89·1	...	.....
Temperature coefficient $= \frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0122 \times (-·036) = -·00044.$							
January 1881.	d. h. m.	d. h. m.					
	8 10 38	8 11 8	25·77		84·5		
				−0·34		+14·1	
	8 20 38	8 23 8	25·43		98·6		
	9 9 8	9 12 38	25·64	−0·27	92·4	+12·7	
	10 6 38	10 18 38	25·70		85·9		
Sums and quotient ...			.....	−0·61	...	+26·8	−·023
Corresponding means ...			25·58	...	91·8	...	.....
Temperature coefficient $= \frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0123 \times (-·023) = -·00028.$							
February 1881.	d. h. m.	d. h. m.					
	24 18 23	24 18 23	25·48		85·7		
				−0·20		+9·5	
	25 1 23	25 2 38	25·28		95·2		
	25 7 38	25 8 38	25·47	−0·18	89·5	+10·2	
	25 18 38	25 20 38	25·46		85·0		
Sums and quotient ...			.....	−0·38	...	+19·7	−·019
Corresponding means ...			25·37	...	90·2	...	.....
Temperature coefficient $= \frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0123 \times (-·019) = -·00023.$							

The sum of all the differences of scale-reading for all the five experiments, divided by the sum of all the differences of temperature $\left[\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}\right]$ is $\frac{-3·26}{125·1} = -·026$; and the mean scale coefficient for the times of the five experiments being ·0122 we have for the final value of the temperature coefficient, $\frac{dX}{ds}\frac{\Sigma\Delta s}{\Sigma\Delta t} = ·0122 \times (-·026) = -·00032.$ This value has been adopted.

112. Periods of steady difference of temperature outside and inside the glass shade were also selected from the observations, and were divided into parts of higher and parts of lower temperature, and these parts were treated like the hot and cold periods of the preced-

ing table. The pairs of differences were much less accordant than those of the preceding selection, and the resulting values of $\frac{\Sigma(\Delta s)}{\Sigma(\Delta f)}$ were, in the order of the experiments, ·000; −·040; −·037; −·018 and −·028 and the general value for all the five experiments −·023. These have been made no use of.

113. During the experiments of January 24 to 27 and January 30 and 31, 1880, the reading of the vacuum gauge of the horizontal force magnetograph was 2·20 inches, but during the other experiments the air in the enclosure had the full pressure of the atmosphere.

Declination Magnetograph.

114. Silk threads are used for the suspension of this instrument, and before being tied on to the suspension-pin and looped through the eyelet of the supporting rod, they were steeped in a solution of shellac in alcohol and afterwards stretched by suspending small weights from them, in single strands, and allowing the weights to swing until the torsion of the threads was removed; and care was taken, in bringing the strands together and in attaching the bunch of them to the brass pieces, to avoid as much as possible introducing new torsion. After placing the socket, carrying the mirror, upon the suspension-pin, the mirror was adjusted for azimuth and to a proper height, and then a brass bar, of the same weight as the magnet, was inserted in the socket and allowed to swing until it came to rest: the torsion head was turned so as to place the position of rest approximately in the magnetic meridian, and it was then possible to read the scale. In June 1870, after the thread had been under its proper tension for several months, the scale was read and the torsion head again turned to eliminate the remaining torsion. Then, for seven days in succession, a single reading was taken—the brass bar occupying the magnet's place—and the mean of these compared with the scale-reading found when the magnet was in place, gave a final correction of the torsion circle reading: the torsion circle was altered accordingly and left with its vernier reading 40° 45′. The mean result of three experiments for determining the torsion force of the suspension thread gave the torsion coefficient 1·0016—the experimental angles of torsion introduced having been +90° and −90°.

115. The following (necessarily rough) measures of the direction of the edge of the declination magnet were made, by comparison with the direction line marked on the marble slab, on the 16th April 1872,—the magnet being blocked in the manner described in paragraph 99 and the scale then read:—

	Scale-reading.	Declination.
	24·68	N 0° 58′ E
	22·80	N 0 44 E
	21·35	N 0 58 E
Means ...	22·94	N 0 53 E

The mean declination in the Electrometer Tower in the month of April 1872 was N 0° 52′·9 E, and the mean scale-reading of the declination magnetograph in the underground room 24·19: assuming that changes of declination are the same in both places, the declination in the Electrometer Tower, when the scale-reading was 22·94, would be $52{\cdot}9 - (24{\cdot}19 - 22{\cdot}94) \times 8{\cdot}13 = \text{N } 0° 42'{\cdot}7 \text{ E}$; or the easterly declination of the place of the declination magnetograph—reckoned by the direction of the edge of the magnet instead of by its magnetic axis—is about 10′ greater than in the Electrometer Tower. For a position near the declination magnetograph we found it (in paragraph 7) to be about 5′ greater, a result which implies—by its near agreement with the other—that the magnetic axis of the declination magnetograph magnet is very nearly parallel to the edge.

116. Periods during which the air in the enclosure of the declination magnetograph was under artificial pressure were as follows:—

Beginning.	Pressure.	End.	Pressure.
	Inches of mercury.		Inches of mercury.
April 19, 1872	2·77	July 29, 1875	6·84
July 23, 1875	2·88	September 19, 1875.	3·90
July 18, 1876	2·28 at which it still remains in December 1882.		

117. For converting variations of the scale-readings or tabulations of the declination magnetograph into variations of east magnetic force, the coefficients that have been used are the products of the monthly values of the horizontal force into the arc-value of a scale division or an inch, the former being taken from Tables 34 and 35 (paragraphs 107 and 108) and the latter being ·002365 or —·00835 as stated in paragraph 12. It may be mentioned here that scale-readings increase and ordinates of the photographic curves decrease with an increase of easterly declination.

118. In the observations given in the foregoing pages, observers have been designated by their several initials : the corresponding names are as follows :—

C. C....	... Charles Chambers.
F. C....	... F. Chambers.
J. E. K.	... J. E. Kohiyar.
V. N.	... Vinayek Narayen.
C. G. T.	... Crishnajee Gunesh Thakoor.
R. S. M.	... Ramcrishna Sukharam Moghey.
P.	... Purshram Luxuman.
V.	... Vishnoo Damodhur.
G.	... Govind Dhondev.
T.	... Tookaram Gunesh.
K. S....	... Keshev Shitaram.
G.	... Govind Narayen.

APPENDIX II.

On the Solar and Lunar variations of magnetic declination at Bombay.

119. The observations discussed in the following pages were made at the Government Observatory at Bombay during the years 1846 to 1872.* With the exception of Sundays, and eight or ten complete days in each year, the observations were taken continuously at hourly intervals throughout the period of twenty-seven years. The observers were Hindoos, generally of the Brahmin caste.

120. The instrument used was made by Grubb of Dublin, and is one of those described in the report (of 1840) of the Committee of Physics of the Royal Society. It is placed in the magnetic observatory and consists of a rectangular bar-magnet suspended horizontally, and carrying a divided scale and a lens, by means of which its position can be determined from time to time by reading the scale with a fixed telescope properly placed. The dimensions of the magnet are 15 inches by 0·86 inch by 0·25 inch, and the broad surface is made to lie horizontal; the suspension-thread was formed of about forty fibres of untwisted silk, and is 35 inches long, being protected (but not concealed from view) by a glass tube 1·3 inch in diameter: the bottom of the glass tube rests upon the top of a cylindrical mahogany box (8·5 inches in height) which surrounds the magnet, and the top supports a horizontal divided circle (the torsion-circle) and a brass cross piece to which the suspension-thread is attached. The tube is secured in a vertical position by a mahogany cross bar which has a circular hole in the middle of it that fits over the upper end of the tube, and which is fixed at its extremities to two copper pillars whose feet are screwed into the marble basement of the instrument; and the upper aperture of the tube with the attachments is screened from the outer air and dust by an inverted hemispherical glass vessel. A sliding-frame which carries above a finely divided scale etched upon glass is fixed by a binding-screw near the northern extremity of the magnet, and a similar frame carrying a lens, whose focal length is about 12·7 inches, is secured to the magnet at that distance to the southward of the glass scale, so that the latter is approximately in the principal focus of the lens. The vertical lines which form the scale are equidistant and generally of uniform length; but every fifth division is slightly and every tenth division considerably prolonged, and over the tenth divisions numbers are marked in consecutive order, thus allowing a numerical designation to be given with facility to every point of the scale when viewed by the telescope. To permit the scale to be viewed through its lens by a telescope outside the mahogany box, the latter has two small windows of flat glass suitably inserted in its curved side, and a lamp is placed on a stool to the northward of the masonry pillar which supports the declinometer, and is kept constantly burning. The joints and crevices, and, for greater security, the whole outside surface of the cylindrical box was covered with paper to keep out small spiders or other insects.

121. The observations are made by a transit instrument (30 inches long and with pivots 15 inches apart) which is fixed on an isolated pillar of masonry, at a distance of 27 feet to the southward of the declinometer pillar, and which in this position is capable of being used also for observing the transits of stars through an opening (provided with shutters) in the roof of the Observatory. This instrument was adjusted in a line with the centres of the scale and lens attached to the magnet, and the telescope was focused so as to give a distinct view of the scale. To ensure greater stability of the instrument its basement was on the 12th May 1853, firmly embedded in masonry. A vertical spider-line is placed in the common principal focus of the object-glass and eye-piece, and the instrument was adjusted so that an object on the true meridian should be cut by this line. With these arrangements any change in the azimuth of the freely suspended magnet is indicated by a change of corresponding magnitude in the position of the image of the collimator scale, as seen in the field of view of the telescope; and the actual position of the magnet at any moment may be found by noting the scale-division that is cut by the reading wire of the telescope, if only we know the position corresponding to any one reading

* The results of the same observations for the years 1859 to 1865 formed the subject of a paper published in the Philosophical Transactions of the Royal Society for 1869.

of the scale, and the change of position for a change of unity in the reading. The latter constant, the scale-coefficient, is easily determined by substituting an azimuth instrument in the place of the transit instrument, and observing with it the horizontal angle included between any two widely different divisions of the scale when the magnet is at rest. Experiments recorded on pages x. and xi. of the "Introduction to the Bombay Magnetical Observations for 1864" showed that the scale was then very correctly placed in the principal focus of its lens, and that the scale-coefficient is 6′·806; but the actual value of the coefficient used in the reduction of the observations was 6′·841, that having been the result of a first determination made in 1845,* when the scale and lens were apparently differently adjusted with respect to each other. The error thus allowed to pass is a little in excess of our general limit of $\frac{1}{100}$th of the whole coefficient.

122. The direction of the magnetic axis of the bar corresponding to a particular scale-reading was found in the following manner:—

First, the level and collimation errors of the transit instrument were approximately destroyed, and the telescope was then pointed upon *Polaris* when on the true meridian, and the azimuthal adjusting-screw turned until the star was bisected by the vertical spider-line at the proper moment, as taken from the Nautical Almanac: it appeared, from observations made in May 1866, and described in detail in the "Introduction to the Bombay Magnetical Observations for 1864," pages x. to xii., that this adjustment was at that time very nearly correct; but until then it seems to have been assumed that the operation described would necessarily direct the reading line of the telescope towards the true north. Secondly, a bundle of about forty threads of untwisted silk having been prepared with care to avoid entangling the different fibres, a brass bar of the same weight as the magnet was suspended and allowed to swing until it took up a position of rest; the arms of the torsion-circle and the attached suspension-pin, to which the upper end of this thread was bound, were then turned in azimuth until the brass bar lay at rest approximately in the true meridian, the magnet was now substituted in place of the brass bar, and a reading of the scale was taken and recorded; next, the magnet being provided with a suspension-hook that allows the bar to be inverted about its own length as an axis without disturbing any of the attachments, this inversion was made and the scale again read. Now the position of the magnetic axis of the bar in the direct and reverse positions would be the same, but the scale-reading would be increased in the one case and diminished in the other, by an amount corresponding to the deviation of the magnetic axis from the true meridian; hence the average of the two readings will give the reading that would be found if the magnet lay with its axis in the true meridian, and half their difference represents the deviation (in scale-divisions) from that position. The scale being placed in an inverted position appears erect in the telescope, and increase of scale-reading implies an easterly movement of the north end of the magnet.

123. One other element, taking account of the magnet being restrained from responding fully to the changes of magnetic force by the torsion force of the suspension thread, enters into the reduction of the observations:—the torsion-force is assumed, as in Coulumb's Electrometer, to be proportional to the angle of torsion, that is, to the deviation of the magnet from the position of no torsion—in this case the true meridian; the torsion coefficient, or unity *plus* the ratio between the torsion force and the directive force of the earth acting upon the particular magnet, is determined by observing the change of scale-reading produced when the arms of the torsion-circle are turned through 90°, dividing the corresponding angle (a) by ($90°$-a), and adding unity to the quotient.

124. The formula used in the reduction of the observations was—

$$\delta = 6'{\cdot}841(f - R)c,$$

where 6′·841 is the adopted value of a unit of the declinometer scale, R the true meridian reading, c the torsion-coefficient, and δ is the absolute easterly declination when f is the observed scale-reading. The values of δ thus obtained, in which form the declination records have been printed in the several volumes of "Bombay Magnetical Observations," form the fundamental data for that part of the following discussion which deals with the observations of 1846 to 1865: for the later years 1866 to 1872 the original scale-readings have been transferred unchanged to the monthly abstracts which will presently be described.

* See Bombay Magnetical and Meteorological Observations, 1845, Introduction, page vi.

125. It ought to be mentioned that the sliding tube of the transit instrument with which the declinometer was read was rather loosely fitted in its socket, a fault which might cause sensible change in the collimation-error whenever the focusing adjustment was used: now since May 1853 and until May 1866 the instrument was turned—sometimes once a month and sometimes once a week—upon a divided scale fixed upon the north wall of the magnetometer-room and was adjusted for distinct vision, after which the adjustment was restored for the collimator scale of the magnetometer. It is suspected that small but important irregularities in the observations, which will be pointed out later, are due chiefly to this fault. The fault is believed, however, to have been effectually removed in May 1866 by packing the sliding tube with thin paper to make a tight fit, and by ceasing from that time to alter the focus of the instrument.

126. Since then the direction pointed to by the reading wire has occasionally been determined in the manner described in the Introduction to the "Bombay Magnetical and Meteorological Observations, 1864," pages viii. to x., with the following results :—

On May 22, 1866	... N 0° 0′·43 W
„ May 23, 1866	... N 0 0·37 W
„ June 7, 1866	... N 0 0·31 W
„ April 24, 1867	... N 0 0·17 W
„ June 10, 1871	... N 0 0·16 W

127. Values of the true meridian reading and of the torsion-coefficient have been determined experimentally, at various times, as follows :—

Date.	True-meridian reading *R.*	Torsion-coefficient *c.*	Remarks.
1845, April 18	25·172	1·0035	
1850, December 30	25·221	1·003546	
1855, December 26	24·8777	1·003443	
1856, January 10—11	22·3537	1·00358	Another magnet substituted from January 11 to 23, 1856.
1856, January 25	28·3064	1·003009	Magnet re-magnetised between January 11 and 25, 1856.
1861, July 8	28·5334	1·00039	
1861, August 13	28·2515	1·00088	
1861, November 2	28·2733	1·0028	
1861, November 9	.....	1·002864	Torsion arm turned.

128. But, with exceptions that will be stated further on, the conversion of scale-readings into minutes of declination has been made, by inserting in the formula of reduction the constants that appear below for the several periods put opposite to them :—

For January 1, 1846 to November 18, 1849	...$\delta = 6{\cdot}868\ (f - 25{\cdot}175)$
„ November 19, 1849 to December 23, 1855	...$\delta = 6{\cdot}868\ (f - 25{\cdot}248)$
„ January 11 to 23, 1856 ...	...$\delta = 6{\cdot}868\ (f - 22{\cdot}231)$
„ January 25, 1856 to July 2, 1861	...$\delta = 6{\cdot}860\ (f - 28{\cdot}379)$
„ July 9 to August 6, 1861 ...	...$\delta = 6{\cdot}844\ (f - 31{\cdot}153)$
„ August 13 to October 27, 1861 ...	...$\delta = 6{\cdot}847\ (f - 28{\cdot}2515)$
„ November 13, 1861 to December 31, 1865	...$\delta = 6{\cdot}860\ (f - 28{\cdot}2733)$

and for 1866 to 1872 the values adopted of the scale-coefficient and of the torsion-coefficient were 6′·841 and 1·0028 and that of their product 6′·860.

129. By comparison of the last two paragraphs it will be seen that although the adopted value of the scale-coefficient, with allowance for torsion, has always been passably near to the value resulting from the several experiments, but little heed has been given to the experimental determinations of the true-meridian reading, whenever these would have caused a sudden and persistent large increase or decrease in the calculated value of the absolute declination. The fact is that the elimination of torsion from a bunch of threads of silk of sufficient strength to support the magnet is so difficult and uncertain of attainment that it is safer to regard the instrument as a differential declinometer only, and to resort to independent means for the determination of the absolute declination. Although such means have been provided and made use of only since the year 1866, yet the treatment that will be applied to the observations under discussion will, for the whole period, be

such only as is appropriate to simple differential observations.* Indeed it will be requisite that strict continuity should be maintained only throughout the observations of each individual month, and even this will be assumed in cases of interruption which do not appear to alter the general flow of the record: in other cases broken portions of a single month will be brought into correspondence by adding to the entries for each hour such *constants* as shall make the mean of each portion the same as that of each other portion.

130. The continuity of the record was interrupted on the following occasions :—

(1.) On the 18th November 1849, when a new vertical force magnet was introduced, causing an increase of ·073 in the scale-reading.

(2.) On the 30th December 1850—by the examination and renewal of adjustments.

(3.) On the 7th August 1851—apparently by a change of the reading telescope.

(4.) On the 30th October 1851—by the breaking and renewal of the reading wire of the telescope.

(5.) On the 6th December 1851—by a change of azimuth of the reading telescope.

(6.) On the 4th April 1853—by change of the reading telescope.

(7.) On the 14th April 1853—by apparent change of the reading telescope.

(8.) On the 22nd April 1853—by change of azimuth of the reading telescope, increasing the scale-reading by 0·41.

(9.) On the 12th May 1853—when the basement of the reading telescope was moved and embedded in masonry, and the azimuthal adjusting screw was afterwards turned so as to place the wire upon the same division of the fixed reference scale as before.

(10.) On the 28th February 1854—by changes of collimation and azimuthal errors of the reading telescope.

(11.) From the 24th December 1855 to the 10th January 1856—by examination and renewal of adjustments.

(12.) From the 11th to 23rd of January 1856—another magnet was substituted for the usual declination magnet.

(13.) On the 24th January 1856—by renewal of adjustment.

(14.) From the 3rd to the 8th July 1861—by stretching and breaking of the suspension thread, and by trial adjustment.

(15.) From the 7th to the 12th August 1861—by trial of a silver suspension wire, and by renewal of adjustment.

(16.) From the 28th October to the 12th November 1861—by repeated unsatisfactory renewal of adjustments.

and (17.) From the 2nd to 4th May 1866—by alteration of collimation adjustment of reading telescope.

131. *Method of reduction of the observations.*—The mode of treatment adopted is that which was introduced by General Sir Edward Sabine and is described by him in the Proceedings of the Royal Society, Vol. X, pp. 624-626, in the following words:—"The hourly directions of the magnet are entered in monthly tables, having the days of the month in successive horizontal lines, and the hours of the day in vertical columns. The 'means' of the entries in each vertical column indicate the mean direction of the magnet at the different hours of the month to which the table belongs, and have received the name of 'First Normals.' On inspecting any such monthly table, it is at once seen that a considerable portion of the entries in the several columns differ considerably from their respective means or first normals, and must be regarded as 'disturbed observations.' The laws of their relative frequency and amount of disturbance, in different years, months, and hours, are then sought out, by separating for that purpose a sufficient body of the most disturbed observations, computing the amount of departure in each case from the normal of the same month and hour, and arranging the amounts, in annual, monthly, and hourly tables. In making these computations, the first normals require to be themselves corrected,

* Except when the observations are applied, in paragraphs 151 to 159, to find the character of the annual variation of declination.

by the omission in each vertical column of the entries noted as disturbed, and by taking fresh means, representing the normals of each month and hour after this omission, and therefore uninfluenced by the larger disturbances. These new means have received the name of 'Final Normals,' and may be defined as being the mean directions of the magnet in every month and every hour, after the omission from the record of every entry which differed from the mean by a certain amount either in excess or in defect.

"In this process there is nothing indefinite, and nothing arbitrary save the assignment of the particular amount of difference from the normal which shall be held to constitute the measure of a large disturbance, and which, for distinction sake, we may call 'the separating value.' It must be an amount which will separate a sufficient body of disturbed observations to permit their laws to be satisfactorily ascertained; but in other respects its precise value is of minor significancy; and the limits within which a selection may be made, without materially affecting the results, are usually by no means narrow; for it has been found experimentally on several occasions that the ratios by which the periodical variations of disturbance in different years, months, and hours are characterized and expressed do not undergo any material change by even considerable differences in the amount of the separating value. The separating value must necessarily be larger at some stations than at others, because the absolute magnitude of the disturbance variation itself is very different in different parts of the globe, as well as its comparative magnitude in relation to the more regular solar-diurnal variation; but it must be a constant quantity throughout at one and the same station, or it will not truly show the relative proportion of disturbance in different years and different months."

132. The first step to be taken was to fix upon a suitable *separating value*, and in doing this regard was paid to the desirableness of having the results derived for Bombay comparable with those for some one of the stations where similar observations had been made and similarly treated. Now the ordinary reductions of the Bombay observations already made showed that the station amongst those which it most nearly resembled was St. Helena; for whilst both are equatorial stations in the sense of the ordinary solar-diurnal variation being at certain seasons over-ridden by the semi-annual inequality of that variation, Bombay has very nearly the same preponderance of the character of a north-latitude station that St. Helena has as a south-latitude station. The separating value adopted by General Sabine in the reduction of the St. Helena observations was 1'·78, or a disturbing force equal to ·0029 English unit; a force of this magnitude acting at Bombay would produce a deviation of the declination-magnet of 1'·25. The value finally fixed upon was 1'·4 which gives the ratio of the number (11,625) of disturbed observations to the total number (197,280) of observations in the twenty-seven years as 1 to 17·0, the similar ratio for St. Helena having been 1 to 13·7. This was for the years 1846 to 1865 when the entries on the monthly abstracts were in minutes of arc: for the years 1866 to 1872 the equivalent in scale divisions (·204) was adopted as the separating value.

133. Trials were also made with separating values 1'·0 for the years 1859 and 1860 and 1·7 for 1860; the results of which (being further confirmatory of the position taken above that "the *ratios* by which the periodical variations of disturbance in different hours are characterized and expressed, do not undergo any material change by even considerable differences in the amount of the separating value") are shown in Tables I to III of Appendix II to the "Bombay Magnetical and Meteorological Observations, 1865-70."

134. The following statement shows all the irregularities of procedure that have been rendered necessary by interruptions of the record and extraneous influences upon the magnet.

(1.) December 31, 1850—Rejected, in taking out disturbances and lunar differences, on account of interruption of record.

(2.) August 1 to 6, 1851—Entries increased by +2'·489, the excess of the mean for a month after over the mean for a month before August 7.

(3.) August 7, 1851—Rejected on account of interruption.

(4.) October 30, 1851—Rejected on account of interruption.

(5.) October 31, 1851—Included with abstract of November 1851.

(6.) December 1 to 5, 1851—Entries increased by —1'·898, the excess of the mean for a month after over the mean for a month before December 6, on account of interruption.

(7.) April 1 to 3, 1853—Entries increased by —3'·184.
(8.) April 4 to 14, 1853— do. do. —1·404.
(9.) April 23 to 29, 1853— do. do. —2·815.
} On account of interruptions.

(10.) September 9 to 20, 1853—Entries increased by −2′·567, the period being noted on the register as subject to correction but without further remark.

(11.) December 24, 1855 to January 10, 1856—Rejected on account of interruptions in the examination and unsatisfactory renewal of adjustments.

(12.) July 3 to 8, 1861—Rejected on account of interruption.

(13.) August 1 to 6—Included with abstract of July 1861.

(14.) August 7 to 12, 1861—Rejected on account of interruption.

(15.) October 28 to November 12, 1861—Rejected on account of interruption.

(16.) December 1 to 3, 1865—Entries increased by 1′·235 on account of a disturbance of the reading wire of the telescope.

(17.) May 2 to 4, 1866—Rejected on account of large and uncertain collimation error of telescope.

(18.) November 1 to 15 and December 17 to 31, 1868, are combined to form one month's abstract which was adopted both for November and December, and the entries for the days in December are increased by +0·144 sc. div., the supposed effect of excavating for the magnetograph room.

(19.) November 16 to 30 and December 1 to 16, 1868—Rejected—excavation for the magnetograph room having been in progress during that time.

And it has, occasionally, been necessary to interpolate a missing entry, but no incomplete days have been embodied in the monthly abstracts.

From January to May 1847 observations were taken at the even hours of the day only, and consequently the disturbances separated are for those hours only; but in calculating the mean diurnal variations for the five months named, values of the "final normals" were interpolated for the odd hours by simply taking the means of those for the preceding and following even hours.

135. The following table shows the number of complete days' observations, comprised in the records made use of, in each month of the twenty-seven years:—

TABLE 38.

Year.	Month.												Total in Year.
	January	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
1846... ...	26	25	26	26	26	26	27	26	26	26	26	27	313
1847... ...	26	24	27	26	26	26	26	27	26	26	26	26	312
1848... ...	26	25	25	25	27	26	26	26	25	27	26	25	309
1849... ...	27	24	26	26	27	25	27	27	25	27	25	24	310
1850... ...	27	24	26	26	27	25	27	27	25	27	26	23	310
1851... ...	27	24	26	26	27	25	27	25	26	25	26	26	310
1852... ...	26	25	27	26	26	26	25	27	26	26	26	26	312
1853... ...	26	24	25	24	27	26	26	26	26	25	26	25	306
1854... ...	27	24	26	24	26	26	26	26	25	26	26	25	307
1855... ...	27	24	25	25	26	25	27	26	25	27	25	19	301
1856... ...	17	25	24	26	26	25	27	25	26	26	25	26	298
1857... ...	26	25	25	25	26	26	27	24	26	25	26	26	307
1858... ...	26	23	27	25	25	26	26	26	26	25	24	25	304
1859... ...	26	24	25	24	26	26	25	26	26	25	26	25	304
1860... ...	26	24	25	25	26	25	26	27	25	27	25	24	305
1861... ...	27	24	23	26	26	25	27	15	26	23	15	25	282
1862... ...	27	23	25	25	26	25	27	25	26	26	25	24	304
1863... ...	26	24	25	25	26	26	27	25	26	26	25	25	306
1864... ...	26	25	25	25	26	26	26	26	26	25	26	25	307
1865... ...	26	23	26	24	26	26	26	27	25	26	26	24	305
1866... ...	26	23	25	25	23	26	26	26	25	27	25	25	302
1867... ...	26	24	24	25	26	25	26	26	25	26	26	25	304
1868... ...	26	24	25	25	25	26	27	25	26	26	12	12	279
1869... ...	25	22	26	26	25	26	27	25	26	26	25	26	305
1870... ...	25	23	26	25	25	26	26	26	26	25	26	27	306
1871... ...	26	23	26	24	26	26	26	26	26	26	25	25	305
1872... ...	26	25	23	26	26	25	27	27	25	26	26	25	307

136. From 1846 to 1865 the first of a day's observations was taken at 0 hour of Göttingen astronomical time, or 16h. 12m. of Colába civil time; and from 1866 to 1872 at 0h. 12m. of Colába civil time. In strictness a proportionate part of the progressive change of declination from month to month should be eliminated from the hourly means at the foot of each monthly abstract, before regarding them as representative of the respective diurnal variations, but as will be shown further on the change at Bombay is small enough to be ignored without involving any material error.

137. The results that follow are all expressed in millimetre-milligramme-second units of force, the conversion having been made by multiplying by the horizontal force and for the years 1846 to 1865 / for the years 1866 to 1872 } by the sine of { 1′ / 6′·860 Results for individual years are multiplied by the horizontal force of that year, those for combined years by the mean horizontal force of the combined years.

138. The following are the values adopted for the horizontal force of the several years:—

Year.	Horizontal Force.	Year.	Horizontal Force.	Year.	Horizontal Force.	Year.	Horizontal Force.	Period.	Horizontal Force.
1846 ...	3·6077	1853 ...	3·6583	1860 ...	3·6899	1867 ...	3·7106	1846 to 1858	3·6487
1847 ...	3·6151	1854 ...	3·6638	1861 ...	3·6935	1868 ...	3·7127	1859 to 1866	3·6980
1848 ...	3·6285	1855 ...	3·6687	1862 ...	3·6969	1869 ...	3·7146	1867 to 1872	3·7151
1849 ...	3·6298	1856 ...	3·6734	1863 ...	3·7001	1870 ...	3·7162	1846 to 1870	3·6748
1850 ...	3·6371	1857 ...	3·6778	1864 ...	3·7031	1871 ...	3·7177	1846 to 1872	3·6780
1851 ...	3·6445	1858 ...	3·6821	1865 ...	3·7056	1872 ...	3·7189		
1852 ...	3·6517	1859 ...	3·6861	1866 ...	3·7083				

139. *Disturbance-variations—diurnal, annual, and secular.*—The following tables exhibit the general results as to diurnal, annual, and secular variations of disturbance when the separating value made use of is 1′·4.

TABLE 39—*Showing for the period* 1846 *to* 1872, *the aggregates of easterly disturbances exceeding* ·00150 *(equivalent to* 1′·4*) in amount for each hour of the day in each month of the year:—*

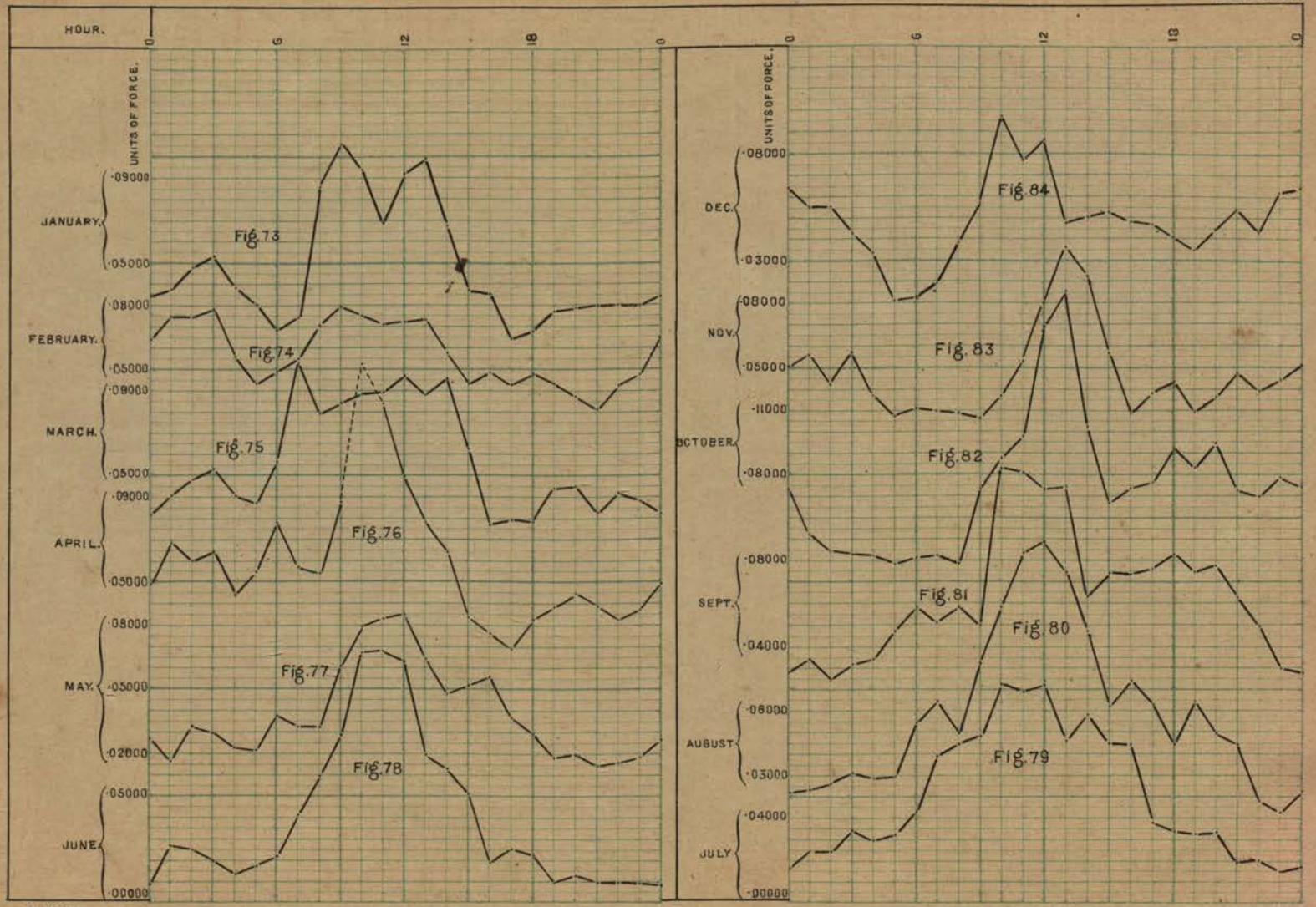
Bombay Civil Hours.	Aggregates of Easterly Disturbances.											
	Jany.	Feby.	March.	April.	May.	June.	July.	August.	Septr.	Octr.	Novr.	Decr.
h. m.												
0 12	·03405	·06377	·03124	·04886	·02545	·00697	·01533	·02071	·02706	·07301	·05007	·06410
1 12	·03720	·07378	·04015	·06829	·01538	·02569	·02402	·02169	·03287	·05093	·05549	·05509
2 12	·04791	·07373	·04766	·05955	·03074	·02445	·02331	·02524	·02404	·04310	·04146	·05503
3 12	·05269	·07800	·05201	·06325	·02944	·01877	·03334	·02997	·03046	·04209	·05693	·04116
4 12	·03752	·05554	·03979	·04393	·02151	·01180	·02918	·02741	·03292	·04101	·03658	·03369
5 12	·03035	·04317	·03620	·05425	·02065	·01597	·03084	·02868	·04669	·03770	·02615	·01007
6 12	·01895	·04894	·05559	·07816	·03684	·02050	·04188	·05351	·05799	·04035	·03016	·01158
7 12	·02399	·05451	·10207	·05567	·03085	·03980	·06864	·06318	·05010	·04084	·02867	·01810
8 12	·08575	·07002	·07867	·05225	·03144	·05879	·07427	·04879	·05754	·03728	·02794	·03816
9 12	·10579	·07922	·08341	·08625	·05982	·07829	·07712	·08131	·04959	·07257	·02504	·05589
10 12	·09374	·07471	·08779	·15151	·07858	·11632	·10077	·10856	·12196	·08571	·03567	·09643
11 12	·06815	·07011	·08858	·13357	·08142	·11673	·09780	·13196	·11997	·09711	·05209	·07619
12 12	·09099	·07176	·09676	·09930	·08431	·11099	·10056	·13841	·11229	·14815	·07953	·08529
13 12	·09947	·07265	·08745	·07750	·06328	·06911	·07508	·12405	·11419	·16521	·10569	·04654
14 12	·06704	·05704	·09527	·06292	·04662	·06100	·08815	·09603	·06134	·10145	·09069	·05006
15 12	·03648	·04352	·06144	·03369	·05047	·04993	·07436	·06098	·07280	·06585	·05580	·05114
16 12	·03498	·04854	·02623	·02543	·05536	·01695	·07349	·07346	·07232	·07253	·02742	·04756
17 12	·01419	·04216	·02880	·01801	·03582	·02436	·03638	·06172	·07522	·07536	·03815	·04613
18 12	·01775	·04741	·02806	·03079	·02909	·02106	·03225	·04427	·08206	·09118	·04277	·04002
19 12	·02666	·04226	·04383	·03748	·01747	·00857	·03153	·06367	·07370	·08242	·02841	·03446
20 12	·02868	·03628	·04481	·04374	·01866	·01185	·03225	·04783	·07650	·09440	·03525	·04412
21 12	·02984	·03028	·03131	·03774	·01303	·00795	·01831	·04330	·06134	·07135	·04686	·05444
22 12	·02999	·04150	·04069	·03118	·01478	·00853	·01988	·01648	·04890	·06895	·03860	·04194
23 12	·02957	·04714	·03760	·03574	·01767	·00776	·01357	·01153	·02920	·07834	·04283	·06110

Curves representing these aggregates are numbered 73 to 84 on Plate VII.

COLABA OBSERVATORY.—DISTURBANCES OF DECLINATION.

AGGREGATES OF EASTERLY DISTURBANCE IN EACH MONTH:—DIURNAL VARIATION.

Plate VII.



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COLABA OBSERVATORY,—DISTURBANCES OF DECLINATION

AGGREGATES OF WESTERLY DISTURBANCE IN EACH MONTH:—DIURNAL VARIATION.

Plate VIII.

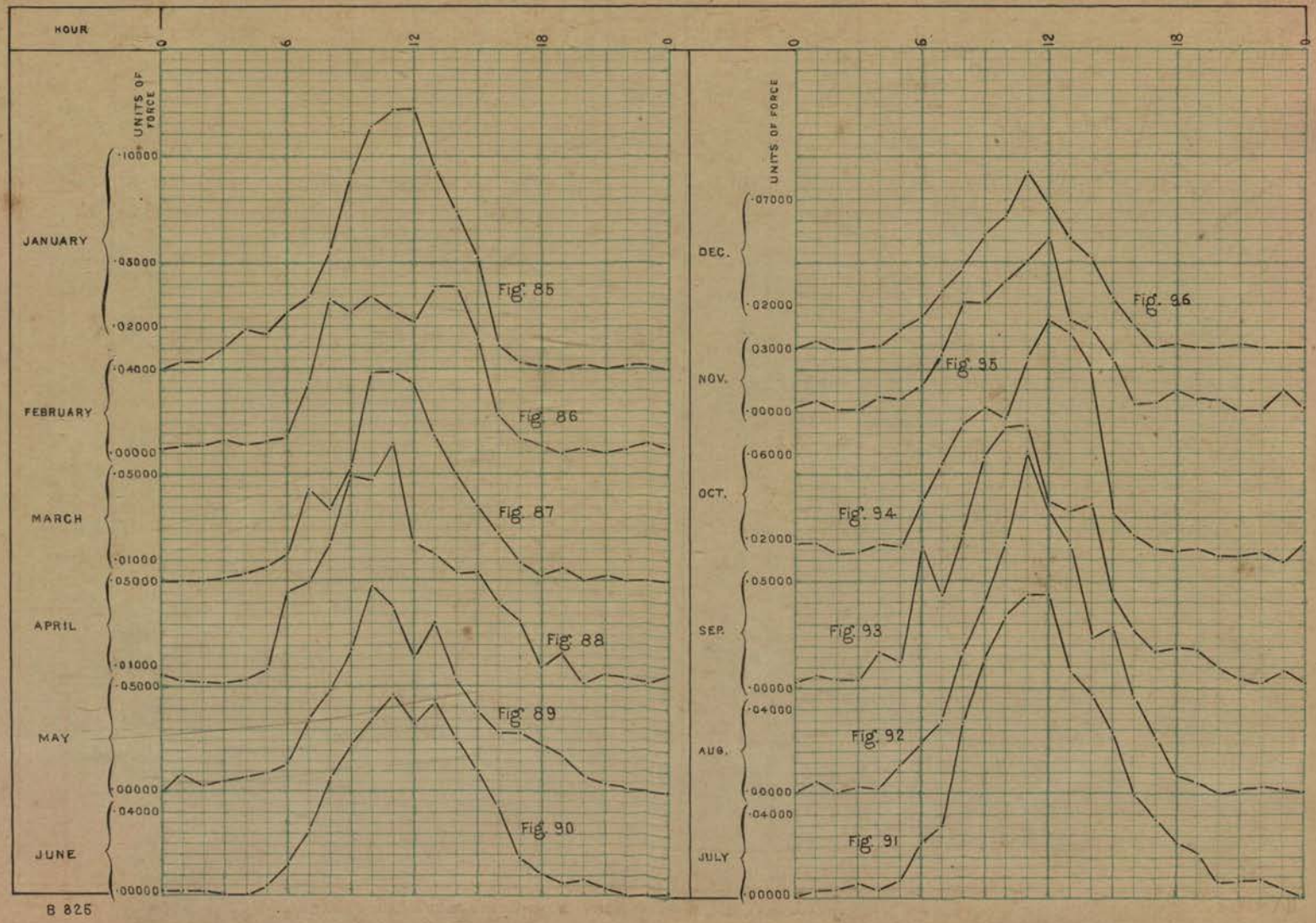

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TABLE 40.—*Showing, for the period* 1846 *to* 1872, *the aggregates of Westerly Disturbances exceeding* ·00150 *(equivalent to* 1″·4*) in amount for each hour of the day in each month of the year.*

Bombay Civil Hours.	AGGREGATES OF WESTERLY DISTURBANCES.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
h. m.												
0 12	·00000	·00221	·00000	·00558	·00000	·00209	·00000	·00000	·00263	·01788	·00203	·00000
1 12	·00385	·00433	·00000	·00252	·00914	·00157	·00333	·00558	·00569	·01860	·00518	·00364
2 12	·00335	·00336	·00000	·00229	·00335	·00179	·00353	·00000	·00458	·01333	·00170	·00000
3 12	·01024	·00578	·00162	·00181	·00558	·00000	·00677	·00365	·00421	·01452	·00144	·00000
4 12	·01853	·00430	·00357	·00308	·00693	·00000	·00387	·00163	·01685	·01747	·00714	·00157
5 12	·01596	·00591	·00630	·00893	·00918	·00462	·00880	·01366	·01196	·01583	·00623	·00835
6 12	·02707	·00858	·01420	·04478	·01388	·01490	·02658	·02440	·06708	·03794	·01190	·01488
7 12	·03344	·03364	·04381	·04965	·03552	·03104	·03483	·03466	·04310	·05521	·02600	·02726
8 12	·05524	·07302	·03355	·06711	·04859	·05632	·08424	·06723	·07155	·07448	·05084	·03723
9 12	·08924	·06628	·05385	·09888	·06775	·07272	·11384	·09009	·10880	·08110	·05037	·05320
10 12	·11385	·07433	·09844	·09730	·09729	·08531	·13320	·11875	·12207	·07687	·06130	·06274
11 12	·12102	·06676	·09935	·11522	·08839	·09620	·14337	·16109	·12361	·10534	·07171	·08324
12 12	·12262	·06187	·09359	·06811	·06311	·08256	·14291	·13292	·08826	·12360	·08079	·06732
13 12	·09468	·07876	·06871	·06166	·08057	·09385	·10844	·11681	·08338	·11613	·04297	·05055
14 12	·07451	·07890	·05036	·05323	·05342	·07485	·09572	·07458	·08581	·09969	·03885	·04243
15 12	·05218	·05454	·03552	·05408	·03863	·06054	·07891	·07854	·04321	·03198	·02502	·02305
16 12	·01982	·01804	·02129	·03958	·02790	·04193	·04925	·04508	·02704	·02173	·00375	·01027
17 12	·00319	·00713	·00905	·03076	·02875	·01935	·03782	·02609	·01732	·01489	·00410	·00000
18 12	·00150	·00349	·00160	·00963	·02275	·01007	·02635	·00851	·01936	·01436	·00980	·00152
19 12	·00000	·00000	·00553	·01561	·01707	·00560	·02180	·00523	·01821	·01502	·00558	·00000
20 12	·00183	·00152	·00000	·00192	·00781	·00849	·00690	·00000	·00971	·01104	·00504	·00000
21 12	·00000	·00000	·00205	·00567	·00348	·00328	·00817	·00160	·00473	·01132	·00000	·00185
22 12	·00157	·00158	·00000	·00496	·00159	·00000	·00867	·00382	·00230	·01394	·00000	·00000
23 12	·00162	·00529	·00000	·00177	·00000	·00000	·00369	·00167	·00889	·00935	·01067	·00000

Curves representing these aggregates are numbered 85 to 96 on Plate VIII.

TABLE 41.—*Showing the aggregates of Easterly Disturbances exceeding* ·00150 *(equivalent to* 1″·4*) in amount for each hour of the day in each of the years* 1846 *to* 1872.

Bombay Civil Hours.	AGGREGATES OF EASTERLY DISTURBANCES.													
	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.														
0 12	·00613	·04232	·03683	·00413	·00413	·01202	·02047	·01554	·02017	·00414	·00000	·01174	·01926	·03960
1 12	·00891	·04646	·03305	·01097	·00406	·01389	·02658	·02180	·02546	·01036	·00173	·01593	·01492	·03417
2 12	·00457	·04299	·02815	·01841	·00968	·01711	·02933	·02946	·01522	·00507	·00263	·01229	·01995	·03111
3 12	·00731	·04317	·02941	·02820	·00680	·01599	·02155	·01793	·01465	·00366	·00000	·00630	·01999	·02739
4 12	·00585	·03043	·02685	·02485	·00499	·01718	·01450	·01293	·01588	·00000	·00000	·00181	·01494	·02407
5 12	·00382	·01944	·01699	·02493	·00363	·01554	·01156	·01895	·00920	·00385	·00000	·00000	·02237	·02456
6 12	·01078	·01799	·01759	·03237	·00537	·00895	·01596	·01223	·01026	·00562	·00166	·00866	·02670	·04030
7 12	·01328	·01862	·02557	·03354	·01982	·01552	·01432	·01106	·01829	·00876	·00256	·00596	·01951	·06396
8 12	·02282	·02734	·02654	·03854	·03108	·02792	·01675	·02352	·01855	·00934	·00000	·01018	·03833	·04630
9 12	·02748	·04362	·04723	·02932	·03426	·02570	·03077	·03069	·02522	·01308	·01246	·01873	·04412	·05333
10 12	·05329	·05868	·06406	·02761	·02944	·03045	·04122	·03824	·03739	·02550	·02898	·03664	·04866	·07694
11 12	·04009	·04760	·08030	·02503	·03159	·04615	·03635	·02890	·01679	·02948	·02154	·02199	·03356	·09708
12 12	·02763	·04186	·07609	·05643	·02252	·05141	·04299	·03135	·02401	·03182	·02093	·02323	·03880	·06138
13 12	·01966	·06024	·05857	·06061	·02374	·03380	·03947	·03197	·02933	·01579	·00999	·02235	·04563	·04898
14 12	·02074	·05078	·06244	·04822	·01713	·03002	·03810	·02712	·02495	·00936	·00696	·02310	·04939	·03286
15 12	·00480	·04614	·02778	·02626	·00778	·01336	·02905	·02121	·02340	·00620	·00598	·01351	·02552	·03126
16 12	·00303	·04262	·02726	·01588	·01028	·00600	·02823	·02264	·00899	·00541	·00000	·00846	·01293	·03803
17 12	·00600	·03726	·03384	·01593	·00575	·02108	·02842	·01567	·00823	·00187	·00000	·00712	·00775	·03184
18 12	·01088	·04961	·03135	·00603	·01610	·01581	·03138	·01349	·00554	·00000	·00178	·01482	·01087	·03082
19 12	·01524	·04005	·03320	·00000	·01019	·01327	·02450	·01699	·01623	·00000	·00348	·01228	·01429	·03677
20 12	·01233	·02899	·02720	·00949	·01135	·02030	·02350	·01840	·01224	·00000	·00193	·01299	·01982	·04646
21 12	·00770	·03920	·04269	·00403	·00837	·01259	·02080	·01430	·01482	·00000	·00180	·01380	·01341	·03383
22 12	·00712	·04081	·03425	·00174	·01130	·01104	·02033	·01441	·01669	·00000	·00214	·00979	·01111	·04489
23 12	·00912	·04370	·02893	·00316	·00718	·01533	·02139	·00798	·01345	·00643	·00164	·00565	·01638	·04333

TABLE 41—*continued.*

Bombay Civil Hours.	AGGREGATES OF EASTERLY DISTURBANCES.												
	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h. m.													
0 12	·02408	·02890	·02319	·00000	·00547	·01054	·00768	·00564	·01420	·01128	·03016	·02341	·03953
1 12	·01981	·02700	·01554	·00941	·00849	·01465	·01248	·00412	·01428	·01495	·02385	·02570	·04168
2 12	·01790	·01462	·02303	·00860	·00994	·01539	·00627	·00441	·01310	·03093	·02034	·03403	·03142
3 12	·02716	·02433	·03086	·01324	·01757	·02220	·00797	·00526	·01706	·03130	·02689	·02698	·03501
4 12	·01920	·02236	·01490	·01140	·01613	·01765	·00551	·00532	·01349	·02083	·02178	·02522	·02274
5 12	·03414	·01423	·01712	·00701	·01690	·00890	·00704	·00252	·00931	·02638	·01972	·02519	·01766
6 12	·06465	·01997	·02135	·00349	·01060	·01535	·00337	·00550	·02021	·02496	·02682	·03427	·03009
7 12	·06616	·02904	·02815	·01610	·01404	·01428	·00365	·00000	·01086	·02646	·01790	·04331	·03602
8 12	·04356	·02912	·02930	·01018	·01393	·00568	·01156	·00864	·01482	·03293	·04461	·03632	·04298
9 12	·03414	·03505	·04867	·01339	·01504	·02097	·02043	·01407	·01462	·04046	·06852	·04594	·04696
10 12	·05360	·03471	·07663	·01965	·03327	·03264	·01514	·02408	·02066	·05254	·08952	·05076	·05129
11 12	·06072	·04088	·07404	·03583	·02675	·03144	·01006	·03050	·02636	·05974	·06883	·05410	·05820
12 12	·05566	·02931	·06780	·06827	·03536	·03192	·02355	·02724	·02984	·07594	·08246	·07209	·06939
13 12	·06181	·02815	·06283	·04878	·03308	·02720	·02820	·03981	·02138	·06031	·05261	·04875	·08775
14 12	·04383	·02429	·04793	·03704	·03950	·03686	·02896	·01428	·00903	·01700	·03758	·03868	·06105
15 12	·04398	·02280	·03491	·01851	·02204	·03137	·01371	·00533	·01860	·01961	·04409	·04126	·05875
16 12	·03124	·01843	·03588	·02458	·01083	·02455	·01663	·00599	·02163	·02910	·05081	·03049	·04525
17 12	·02073	·00822	·05261	·01745	·01888	·01702	·00839	·00458	·03183	·01913	·00922	·02962	·03803
18 12	·02427	·00713	·02806	·02513	·02027	·02700	·01291	·00790	·01779	·01953	·01595	·02483	·03740
19 12	·03768	·01485	·02244	·02031	·00619	·01416	·01501	·00203	·01574	·02758	·03236	·01715	·02848
20 12	·03202	·02180	·03298	·02070	·00868	·01767	·01130	·00434	·01529	·01890	·03516	·02108	·02972
21 12	·02864	·01553	·02088	·00833	·01101	·02060	·01283	·00161	·00941	·02046	·03134	·01844	·01906
22 12	·02535	·01794	·01594	·00429	·00519	·01225	·00865	·00413	·00989	·00853	·03955	·01002	·01363
23 12	·02306	·02309	·02530	·00663	·00411	·00604	·00742	·00176	·00828	·01199	·04159	·01221	·01653

Curves representing these aggregates are numbered 97 to 123 on Plate IX.

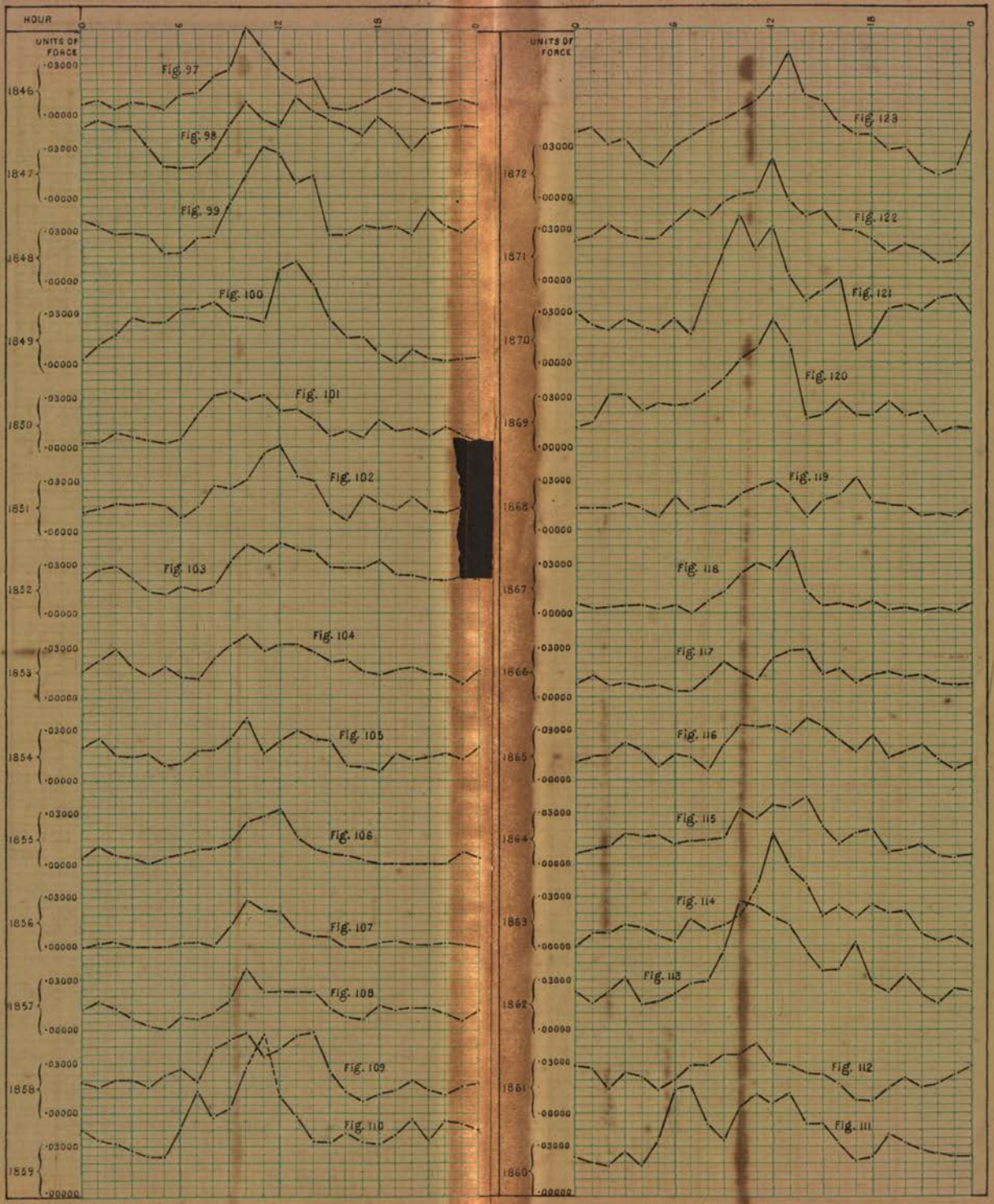
TABLE 42.—*Showing the aggregates of Westerly Disturbances exceeding* ·00150 *(equivalent to* 1·4*) in amount for each hour of the day in each of the years* 1846 *to* 1872.

Bombay Civil Hours.	AGGREGATES OF WESTERLY DISTURBANCES.												
	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.														
0 12	·00000	·00000	·00000	·00218	·00000	·00207	·00000	·00161	·00000	·00000	·00000	·00000	·00264	·00203
1 12	·00000	·00000	·00487	·00000	·00000	·00159	·00353	·00763	·00224	·00000	·00000	·00361	·00623	·00000
2 12	·00000	·00000	·00167	·00165	·00000	·00000	·00000	·00178	·00000	·00000	·00000	·00000	·00386	·00000
3 12	·00000	·00223	·00000	·00000	·00000	·00000	·00562	·00432	·00474	·00000	·00000	·00388	·00451	·00000
4 12	·00317	·00554	·00172	·00000	·00000	·00000	·00517	·00846	·00159	·00172	·00000	·01116	·01109	·00000
5 12	·00000	·00372	·00454	·00388	·00153	·00000	·00665	·00702	·00398	·00000	·00000	·00977	·00746	·00309
6 12	·00482	·01104	·01940	·00947	·01016	·00975	·02270	·01166	·00000	·00182	·00000	·00811	·01020	·02774
7 12	·00919	·01684	·02936	·02324	·01013	·01233	·02094	·01668	·01196	·00532	·00000	·01730	·00910	·01457
8 12	·02046	·03136	·03883	·03439	·02160	·03185	·03866	·02314	·01116	·01081	·01281	·03365	·01710	·02494
9 12	·02921	·04488	·03407	·03567	·04112	·03018	·03485	·02822	·01815	·02537	·01645	·05326	·04381	·05507
10 12	·02968	·06221	·04128	·05406	·05247	·03834	·03041	·03894	·02523	·03793	·03060	·02998	·04330	·05746
11 12	·04988	·06679	·04647	·08621	·05288	·03202	·04865	·03303	·03531	·02358	·04087	·04802	·05600	·07678
12 12	·04449	·04921	·05942	·04794	·03934	·03582	·04027	·02608	·03727	·02356	·01836	·04658	·05876	·08921
13 12	·02222	·04297	·06563	·04490	·03093	·04192	·02427	·03499	·01842	·01879	·00378	·03735	·04333	·08129
14 12	·02140	·03769	·04014	·04474	·02539	·04533	·02667	·03584	·01327	·00922	·00722	·02433	·03157	·05140
15 12	·02090	·02052	·04396	·03722	·01110	·02492	·02113	·01783	·02022	·00448	·00176	·01416	·02417	·01819
16 12	·00999	·01045	·01804	·01382	·00684	·00974	·01326	·00518	·00545	·00000	·00000	·00354	·00667	·01610
17 12	·00537	·00304	·01428	·00911	·00175	·00320	·00473	·00608	·00740	·00000	·00000	·00764	·00650	·00848
18 12	·01099	·00322	·00779	·00148	·00000	·00157	·00539	·00351	·00171	·00000	·00000	·00746	·00303	·00506
19 12	·00339	·00077	·00719	·00000	·00187	·00333	·00557	·00699	·00000	·00157	·00000	·00300	·00364	·00350
20 12	·00000	·00000	·00677	·00000	·00000	·00000	·00000	·00411	·00000	·00179	·00000	·00000	·00341	·00000
21 12	·00150	·00000	·00183	·00000	·00183	·00000	·00203	·00296	·00170	·00000	·00000	·00000	·00169	·00000
22 12	·00000	·00000	·00000	·00156	·00000	·00000	·00156	·00178	·00000	·00000	·00000	·00000	·00230	·00000
23 12	·00000	·00185	·00653	·00183	·00000	·00487	·00000	·00000	·00165	·00201	·00000	·00162	·00236	·00217

COLABA OBSERVATORY.—DISTURBANCES OF DECLINATION.

AGGREGATES OF EASTERLY DISTURBANCE IN EACH YEAR:—DIURNAL VARIATION.

Plate IX.



COLABA OBSERVATORY,—DISTURBANCES OF DECLINATION.

AGGREGATES OF WESTERLY DISTURBANCE IN EACH YEAR:— DIURNAL VARIATON.

Plate X.

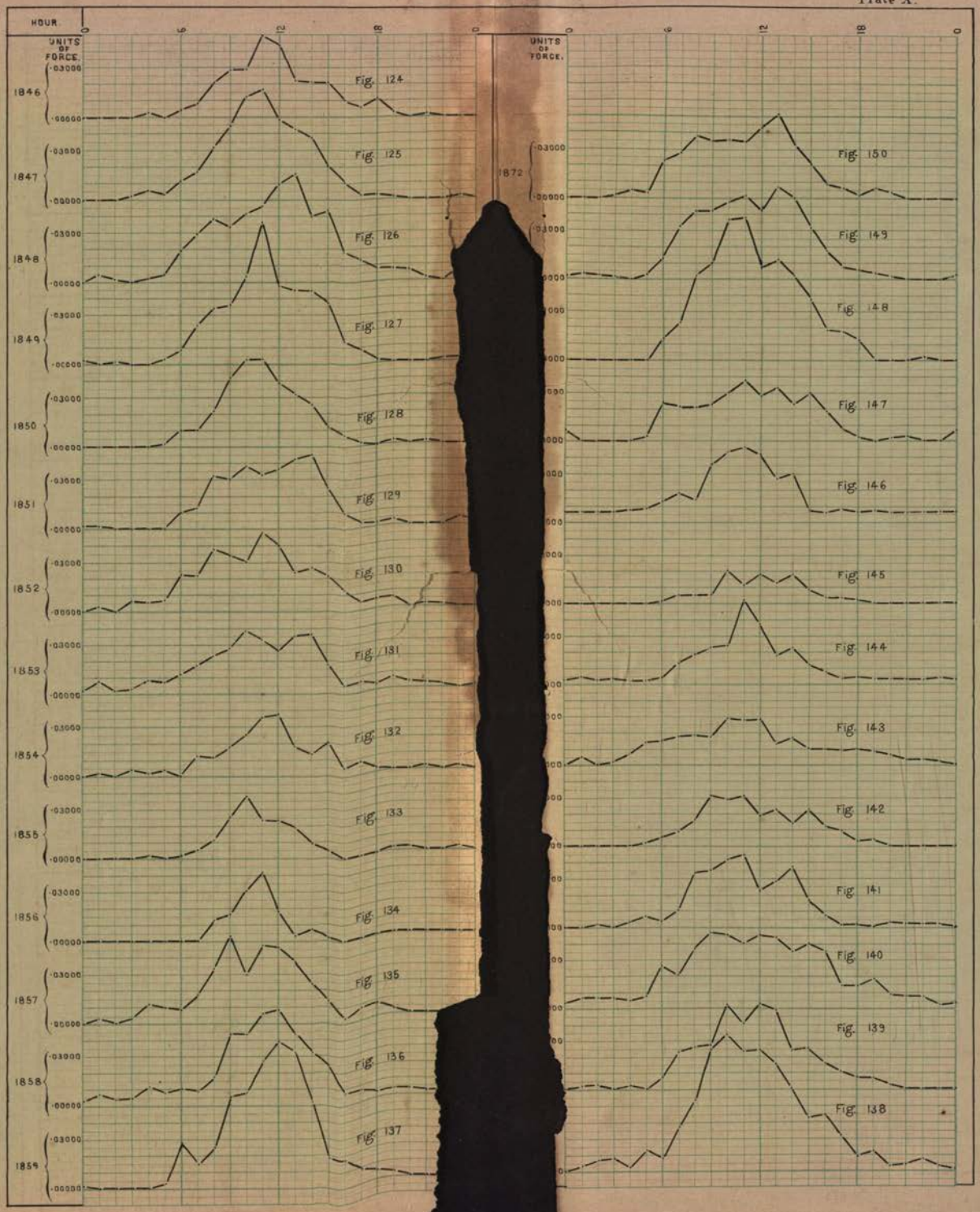


TABLE 42—*continued.*

Bombay Civil Hours.	AGGREGATES OF WESTERLY DISTURBANCES.												
	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h. m.													
0 12	·00000	·00000	·00394	·00000	·00000	·00000	·00267	·00000	·00668	·00668	·00000	·00206	·00000
1 12	·00334	·00167	·00702	·00000	·00000	·00530	·00493	·00000	·00723	·00000	·00000	·00440	·00000
2 12	·00586	·00230	·00700	·00178	·00000	·00000	·00222	·00000	·00702	·00000	·00000	·00226	·00000
3 12	·00725	·00000	·00690	·00000	·00000	·00184	·00433	·00000	·00691	·00000	·00000	·00159	·00157
4 12	·00216	·00157	·00525	·00393	·00000	·00718	·00210	·00000	·00818	·00000	·00000	·00000	·00496
5 12	·01256	·00000	·00741	·00586	·00169	·01442	·00232	·00000	·00968	·00327	·00000	·00352	·00354
6 12	·00840	·00733	·02577	·00388	·00513	·01486	·00461	·00173	·01288	·02449	·01367	·01340	·02345
7 12	·02702	·02318	·02009	·01015	·00920	·01770	·01374	·00523	·01918	·02079	·02352	·03329	·02839
8 12	·04392	·02566	·03627	·03380	·01622	·01870	·01911	·00537	·01467	·02070	·05226	·04331	·03856
9 12	·07462	·02692	·04628	·03494	·03114	·01710	·02279	·00537	·03574	·02314	·06003	·04242	·03527
10 12	·08398	·05216	·04486	·04082	·02925	·02884	·02402	·01985	·04432	·03005	·08657	·04843	·03628
11 12	·07314	·04030	·04008	·04472	·03079	·02736	·05182	·01077	·04600	·03804	·08858	·05149	·03475
12 12	·07436	·05360	·04518	·02213	·01860	·02883	·03736	·01874	·04138	·02781	·05709	·04229	·04338
13 12	·06498	·04944	·04462	·02900	·02295	·01275	·01796	·01248	·02732	·03394	·06207	·05683	·05132
14 12	·04969	·02432	·03554	·03696	·01387	·01720	·02272	·01856	·03011	·02334	·05203	·04996	·03374
15 12	·03158	·02526	·04007	·01646	·02331	·01022	·01166	·00888	·00790	·02997	·03807	·03120	·02078
16 12	·03442	·01553	·03463	·00742	·01204	·00981	·00889	·00350	·00589	·01957	·01867	·01863	·00890
17 12	·02084	·01022	·01394	·00153	·00974	·00910	·00491	·00368	·00926	·00742	·01726	·00722	·00604
18 12	·00860	·00699	·01290	·00151	·00271	·00971	·00504	·00167	·00660	·00230	·01275	·00541	·00162
19 12	·01089	·00592	·01840	·00000	·00406	·00852	·00298	·00000	·00770	·00000	·00000	·00409	·00641
20 12	·00173	·00186	·00907	·00338	·00000	·00591	·00305	·00000	·00610	·00155	·00000	·00157	·00412
21 12	·00335	·00000	·00775	·00162	·00000	·00313	·00291	·00000	·00642	·00351	·00000	·00000	·00000
22 12	·00691	·00000	·00736	·00158	·00000	·00385	·00304	·00000	·00706	·00000	·00160	·00000	·00000
23 12	·00168	·00000	·00178	·00163	·00000	·00168	·00454	·00000	·00669	·00000	·00000	·00000	·00000

Curves representing these aggregates are numbered 124 to 150 on Plate X.

TABLE 43.—*Showing, for each hour of the day and for the whole day,* (1) *the aggregates of Easterly and of Westerly disturbances, including and excluding the separating value,* (2) *the same in terms of the average aggregate for the twenty-four hours,* (3) *the number of observations separated as disturbed,* (4) *the algebraical sum of all the disturbances, those to the eastward being reckoned as positive and those to the westward as negative, and* (5) *the average disturbance per day,—all being derived from the observations of the years* 1846 *to* 1872.

Bombay Civil Hours.	EASTERLY DISTURBANCES.					WESTERLY DISTURBANCES.					EASTERLY *minus* WESTERLY DISTURBANCES.	
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.	
	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Average disturbance *per* day. Column 12 ÷8220.
1	2	3	4	5	6	7	8	9	10	11	12	13
h. m.												
0 12	0·46061	0·72	187	0·18051	0·87	0·03242	0·08	10	0·01745	0·16	+0·42819	+·000052
1 12	0·50023	0·78	207	0·19050	0·92	0·06343	0·16	31	0·01700	0·16	+0·43680	+·000053
2 12	0·49621	0·78	203	0·19215	0·93	0·03728	0·09	16	0·01332	0·12	+0·45893	+·000056
3 12	0·52810	0·83	232	0·18060	0·87	0·05561	0·14	25	0·01817	0·17	+0·47249	+·000057
4 12	0·41088	0·64	179	0·14276	0·69	0·08494	0·21	41	0·02353	0·21	+0·32594	+·000040
5 12	0·38072	0·60	168	0·12908	0·62	0·11574	0·29	57	0·03037	0·28	+0·26498	+·000032
6 12	0·49445	0·77	225	0·15743	0·76	0·30621	0·76	146	0·08753	0·80	+0·18824	+·000023
7 12	0·57642	0·90	276	0·16301	0·79	0·44816	1·11	219	0·12014	1·10	+0·12826	+·000016
8 12	0·66091	1·03	323	0·17710	0·85	0·71939	1·78	355	0·18766	1·71	—0·05848	—·000007
9 12	0·85429	1·34	413	0·23568	1·13	0·94614	2·35	457	0·26162	2·39	—0·09185	—·000011
10 12	1·15174	1·80	538	0·34589	1·67	1·14146	2·83	542	0·32963	3·01	+0·01028	+·000001
11 12	1·13369	1·77	528	0·34282	1·65	1·27529	3·16	600	0·37658	3·44	—0·14160	—·000017
12 12	1·21830	1·91	564	0·37350	1·80	1·12768	2·80	540	0·31884	2·91	+0·09062	+·000011
13 12	1·10022	1·72	506	0·34230	1·65	0·99649	2·47	485	0·27003	2·47	+0·10373	+·000013
14 12	0·87760	1·37	426	0·23952	1·15	0·82235	2·04	415	0·20074	1·83	+0·05525	+·000007
15 12	0·65645	1·03	310	0·19211	0·93	0·57620	1·43	302	0·12385	1·13	+0·08025	+·000010
16 12	0·57427	0·90	260	0·18482	0·89	0·31667	0·79	168	0·06503	0·59	+0·25760	+·000031
17 12	0·49631	0·78	212	0·17876	0·86	0·19845	0·49	99	0·05017	0·46	+0·29786	+·000036
18 12	0·50672	0·79	215	0·18468	0·89	0·12893	0·32	61	0·03757	0·34	+0·37779	+·000046
19 12	0·49047	0·77	203	0·18640	0·90	0·10964	0·27	56	0·02577	0·24	+0·38083	+·000046
20 12	0·51438	0·80	218	0·18785	0·91	0·05426	0·13	27	0·01383	0·13	+0·46012	+·000056
21 12	0·44574	0·70	186	0·16714	0·80	0·04215	0·10	20	0·01219	0·11	+0·40359	+·000049
22 12	0·40143	0·63	168	0·14979	0·72	0·03843	0·10	17	0·01298	0·12	+0·36300	+·000044
23 12	0·41206	0·64	169	0·15892	0·77	0·04296	0·11	20	0·01301	0·12	+0·36910	+·000045
Total ...	15·34220	...	6916	4·98332	...	9·68028	...	4709	2·62701	...	+5·66192	+·000689
Mean ...	0·63926	...	...	0·20764	...	0·40334	...	...	0·10946	...	+0·23591	+·000029

The numbers in columns 3 and 8 are curved in Figs. 151 and 152, those in columns 6 and 11 in Figs. 157 and 158, and those in column 13 in Fig. 163. (Plate XI.)

TABLE 44.—*Showing, for each month and for the whole year,* (1) *the aggregates of Easterly and of Westerly disturbance, including and excluding the separating value,* (2) *the same in terms of the average aggregate for the twelve months, and* (3) *the numbers of observations separated as disturbed,—all being derived from the observations of the years* 1846 *to* 1872.

Months.	Easterly Disturbances.					Westerly Disturbances.					Easterly *plus* Westerly Disturbances.				
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.	
	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
January ...	1·14172	0·89	550	0·31790	0·77	0·85632	1·06	422	0·22422	1·02	1·99804	0·96	972	0·54212	0·85
February ...	1·36599	1·07	604	0·46128	1·11	0·65962	0·82	321	0·17880	0·82	2·02561	0·97	925	0·64009	1·01
March ...	1·36542	1·07	635	0·41428	1·00	0·64239	0·80	323	0·15858	0·72	2·00780	0·96	958	0·57285	0·90
April	1·42904	1·12	624	0·49438	1·19	0·84413	1·05	415	0·22252	1·02	2·27318	1·09	1039	0·71690	1·13
May	0·90869	0·71	429	0·26011	0·64	0·73066	0·91	366	0·18259	0·83	1·63935	0·79	795	0·44869	0·71
June	0·93215	0·73	457	0·24763	0·60	0·76708	0·95	376	0·20388	0·93	1·69923	0·81	833	0·45152	0·71
July	1·21232	0·95	572	0·35554	0·86	1·15100	1·43	559	0·31370	1·43	2·36332	1·13	1131	0·66924	1·06
August ...	1·42274	1·11	651	0·44703	1·08	1·01559	1·26	490	0·28164	1·29	2·43833	1·17	1141	0·72927	1·15
September ...	1·53104	1·20	666	0·53347	1·28	0·99036	1·23	480	0·27139	1·24	2·52140	1·21	1146	0·80486	1·27
October ...	1·77687	1·39	746	0·65947	1·59	1·01162	1·25	449	0·33908	1·55	2·78849	1·34	1195	0·99855	1·57
November ...	1·09825	0·86	488	0·36729	0·88	0·52241	0·65	264	0·12698	0·58	1·62066	0·78	752	0·49427	0·78
December ...	1·15828	0·91	494	0·41834	1·01	0·48909	0·61	244	0·12361	0·56	1·64737	0·79	738	0·54195	0·85
Total ...	15·34251	..	6916	4·98332	...	9·68027	...	4709	2·62699	...	25·02278	...	11625	7·61031	...
Mean ...	1·27854	...	...	0·41528	...	0·80669	...	...	0·21892	...	2·08523	...	...	0·63419	...

The numbers in columns 3 and 8 are curved in Figs. 153 and 154, those in columns 6 and 11 in Figs. 159 and 160, and those in columns 13 and 16 in Figs. 164 and 165 (Plate XI.)

TABLE 45.—*Showing, for the years* 1846 *to* 1872 *and for the whole period,* (1) *the aggregates of Easterly and of Westerly disturbance, including and excluding the separating value,* (2) *the same in terms of the average yearly aggregate, and* (3) *the number of observations separated as disturbed.*

Years.	Easterly Disturbances.					Westerly Disturbances.					Easterly *plus* Westerly Disturbances.				
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.	
	Aggregates	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1846	0·34859	0·63	173	0·09440	0·52	0·28666	0·80	153	0·06185	0·64	0·63525	0·69	326	0·15626	0·55
1847	0·95992	1·72	383	0·39605	2·18	0·41431	1·16	198	0·12281	1·26	1·37423	1·48	581	0·51886	1·84
1848	0·91615	1·64	411	0·30979	1·70	0·49379	1·38	244	0·13381	1·37	1·40994	1·52	655	0·44360	1·57
1849	0·54568	0·97	268	0·14950	0·82	0·45335	1·26	224	0·12222	1·26	0·99902	1·08	492	0·27172	0·96
1850	0·33655	0·60	171	0·08327	0·46	0·30893	0·86	149	0·08823	0·91	0·64548	0·70	320	0·17150	0·61
1851	0·49045	0·87	224	0·15797	0·86	0·32883	0·92	165	0·08392	0·86	0·81928	0·88	389	0·24190	0·86
1852	0·62750	1·11	291	0·19472	1·06	0·36205	1·01	181	0·09286	0·95	0·98955	1·07	472	0·28758	1·02
1853	0·49679	0·88	235	0·14666	0·80	0·32786	0·91	168	0·07756	0·80	0·82465	0·89	403	0·22423	0·80
1854	0·42496	0·75	205	0·11908	0·65	0·22145	0·62	118	0·04538	0·47	0·64641	0·70	323	0·16446	0·58
1855	0·19573	0·35	103	0·04184	0·23	0·16797	0·47	87	0·03798	0·39	0·36370	0·39	190	0·07982	0·28
1856	0·12818	0·23	70	0·02346	0·13	0·13185	0·37	69	0·02862	0·29	0·26003	0·28	139	0·05208	0·18
1857	0·31734	0·56	149	0·09416	0·51	0·36441	1·02	174	0·10378	1·07	0·68175	0·74	323	0·19794	0·70
1858	0·58819	1·03	267	0·18782	1·02	0·40273	1·12	195	0·11032	1·13	0·99093	1·07	462	0·29814	1·06
1859	1·03929	1·82	417	0·41328	2·23	0·53708	1·50	255	0·15427	1·59	1·57637	1·70	672	0·56755	2·01
1860	0·89339	1·57	385	0·31482	1·70	0·65126	1·82	301	0·19893	2·04	1·54465	1·67	686	0·51376	1·82
1861	0·55178	0·97	262	0·15769	0·85	0·37422	1·04	188	0·09144	0·94	0·92600	1·00	450	0·24913	0·88
1862	0·85035	1·49	388	0·26619	1·43	0·52213	1·46	262	0·12767	1·31	1·37247	1·48	650	0·39386	1·40
1863	0·44831	0·78	217	0·12133	0·65	0·30312	0·85	155	0·06956	0·71	0·75143	0·81	372	0·19089	0·68
1864	0·40327	0·70	198	0·10467	0·56	0·23070	0·64	120	0·04973	0·51	0·63397	0·68	318	0·15440	0·55
1865	0·47634	0·83	232	0·12620	0·68	0·27395	0·76	134	0·07172	0·74	0·75029	0·81	366	0·19792	0·70
1866	0·29873	0·52	143	0·08278	0·44	0·27970	0·78	122	0·09544	0·98	0·57843	0·62	265	0·17822	0·63
1867	0·22907	0·40	110	0·06284	0·34	0·11582	0·32	61	0·02364	0·24	0·34490	0·37	171	0·08649	0·31
1868	0·39769	0·69	179	0·12754	0·68	0·38092	1·06	147	0·15866	1·63	0·77861	0·84	326	0·28570	1·01
1869	0·70085	1·22	297	0·25154	1·35	0·31057	0·88	157	0·07905	0·81	1·01742	1·10	454	0·33059	1·17
1870	0·93168	1·62	388	0·34448	1·85	0·54415	1·63	263	0·18613	1·91	1·51583	1·64	651	0·53061	1·88
1871	0·78984	1·38	359	0·24633	1·32	0·46335	1·29	230	0·11514	1·18	1·25320	1·35	589	0·36147	1·28
1872	0·95862	1·67	391	0·36644	1·96	0·38309	1·07	189	0·09685	1·00	1·34171	1·45	580	0·46329	1·64
Total ..	15·34524	...	6916	4·98435	..	9·68025	...	4709	2·62757	...	25·02550	...	11625	7·61197	...
Mean ...	0·56834	...	...	0·18461	...	0·35853	...	...	0·09732	...	0·92687	...	...	0·28192	...

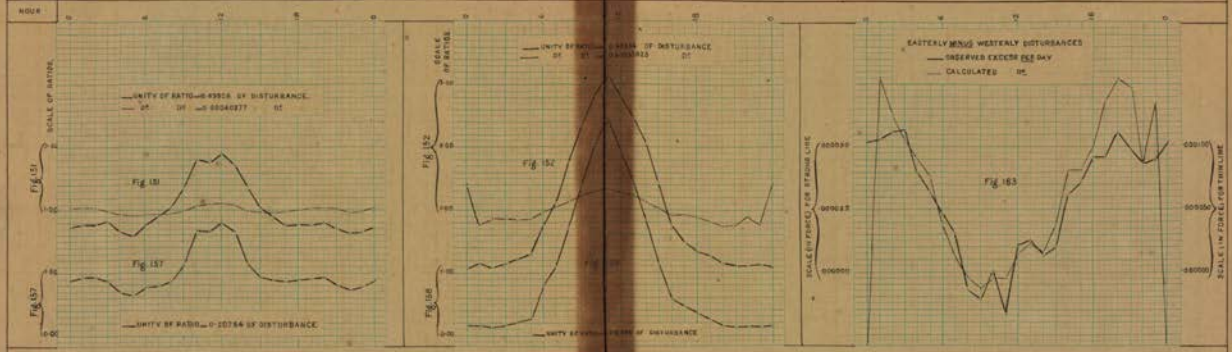
The numbers in columns 3 and 8 are curved in Figs. 155 and 156, those in column 6 and 11 in Figs. 161 and 162, and those in columns 13 and 16 in Figs. 166 and 167 (Plate XI.)

COLABA OBSERVATORY.— DISTURBANCES OF DECLINATION.

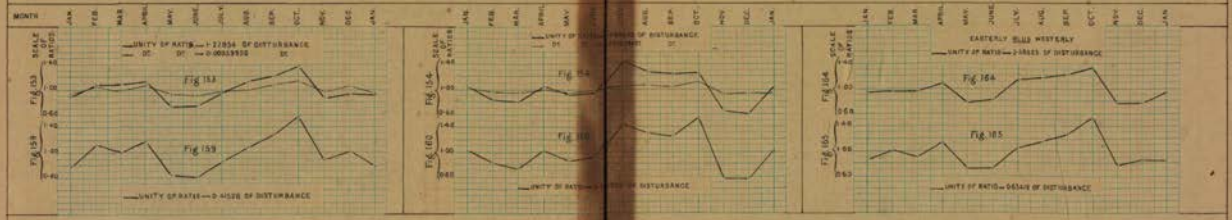
—UPPER STRONG LINES REPRESENT RATIOS OF LARGER DISTURBANCES.— CALCULATED TOTAL DISTURBANCE PER DAY.— LOWER STRONG LINES REPRESENT RATIOS OF THAT PART ONLY OF THE DISTURBANCES WHICH IS IN EXCESS OF 1-4 Plate XI

EASTERLY | WESTERLY

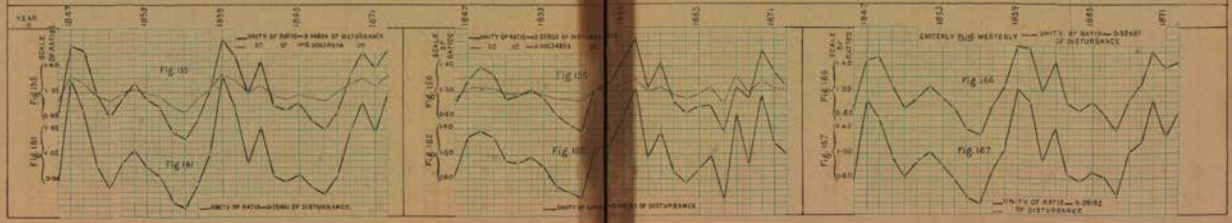
DIURNAL VARIATION.



ANNUAL VARIATION.



SECULAR VARIATION.



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140. *Remarks on the Disturbance-variations.*—At nearly all stations whose disturbance-diurnal variation curves have been found by the process described above, one or other of these curves, either the easterly or the westerly, closely corresponds in shape to a general type. The westerly disturbance-diurnal variation curve for Bombay conforms to this type, of which the characteristics are, that during about half the day the ordinates are very small, whilst there is a gradual and regular rise on either side of this quiescent period towards a maximum, which occurs near the middle of the remaining part of the day; such curves are the easterly for Kew, St. Helena, Toronto, and the Cape of Good Hope, and the westerly for Hobartown, St. Helena, Pekin, and Nertschinsk. The correspondence as to shape does not, however, hold as to time, either absolute or local, for the hours of maxima are not confined to any particular portion of the day. The Bombay hours of little or no westerly disturbance are from 18 to 5, the considerable and regular variation from hour to hour occurring during the remaining hours. The principal features of the easterly disturbance-diurnal variation curve for Bombay are like those of the westerly curve, with this distinction, that there is a considerable amount of easterly disturbance at all hours of the day, the least hourly ratio being 0·60; the easterly curve is also less remarkably regular than the westerly. There is great similarity in the declination disturbance-diurnal variations of St. Helena and Bombay, and the principal inflections of the curves occur at the same local hours; but the night-hours at St. Helena are, unlike the same at Bombay, almost entirely free from easterly disturbance. In the disturbance-annual variations there is, as at Toronto, a tendency, though not very decided towards double maxima and minima; the maxima occurring in the case of the easterly disturbances about the equinoxes and in the case of the westerly disturbances about the solstices. In the secular variation curves of both easterly and westerly disturbance the sun-spot period is prominently brought out, the years of maximum being 1847-48, 1859-60 and 1870-72 in the easterly disturbance curve, and 1848, 1860 and 1870 in the westerly disturbance curve, and the years of minimum being 1856 and 1867 in both curves. The ratios of disturbance for the maximum and minimum years (or mean years), in order, are 1·68; 0·23; 1·69; 0·40 and 1·56 for the easterly disturbances and 1·38; 0·37; 1·82; 0·32 and 1·63 for the westerly disturbances. The disturbance-diurnal variation curve shows a preponderance of easterly disturbance at all hours except 8h., 9h. and 11h.: the preponderance from 16h. to 5h. is great, but it is less considerable during the remaining hours. On the whole the proportion of aggregate easterly disturbance to westerly is as 1·6 to 1.

141. Two sets of tables and two corresponding sets of curves are employed to represent the disturbance-variations—diurnal, annual and secular, the one set including and the other excluding that part of a disturbance which lies within the limits ± 1′·4 of the normal declination. If E_r represent the aggregate disturbance at one hour, month or year, and ΣE_r the aggregate for all the hours, months or years, and if the number of disturbances embodied in E_r be n_r and C be the constant separating value, then the second set of aggregates is obtained from the first by subtracting $n_r C$ from the E_r of each hour, month or year. Now the disturbance aggregate of a particular hour (say) may be large either by reason of a greater number of disturbances of a given value occurring at that hour than at others, or by the same number of disturbances occurring but by their being of a larger average magnitude. The relation between the two sets of ratios should serve as a criterion for attributing a large ratio to greater frequency or to greater magnitude of disturbance: for if the two sets of ratios are practically identical throughout, we have—N being the number of hours, months or years,—

$$\frac{E_r}{\frac{\Sigma E_r}{N}} = \frac{E_r - n_r C}{\frac{\Sigma (E_r - n_r C)}{N}} \qquad \text{or}$$

$$E_r \Sigma E_r - E_r \Sigma n_r C = E_r \Sigma E_r - n_r C \Sigma E_r, \text{ whence}$$

$$\frac{E_r}{n_r} = \frac{\Sigma E_r}{\Sigma n_r}$$

or the average value of a disturbance is the same for each hour, month or year (r), and the difference in the aggregates must then arise from a difference in the frequency of occurrence of disturbances at different hours, months or years. The near approach to identity of form in the two sets of curves, both of easterly and westerly disturbance, and both of the diurnal, annual and secular disturbance variations (Figs. 151 to 162 of Plate XI.) seems to lend some support to this view.

142. But looking to the fact that the disturbance diurnal variations of different stations show preponderance of disturbance at different hours of *absolute* time, and to the fairly established fact that disturbances are of cosmical origin, the inherent improbability of the occurrence of disturbances depending upon the local time of any one station leads us to examine the converse proposition, that it is upon the magnitude and not on the frequency of disturbance that the variation of the aggregates depends. In order to do this, we assume that the distribution of disturbances (considered in one direction only at a time) follows the law of the distribution of errors of observation, so that our numbers of disturbances and aggregates of disturbance may be compared to the number of bullet-marks on a target outside a particular circle and the aggregate distances of these marks from the centre of the target, and half the total number of observations employed in the separation of disturbances will correspond to the total number of shots upon the target.

From Airy's Theory of Errors of Observations (1861) we obtain (page 21) for the number of positive errors between the limits $\frac{x}{c}$ and ∞.

$$\frac{A}{c\sqrt{\pi}}\int_{\frac{x}{c}}^{\infty} \epsilon^{-\frac{x^2}{c^2}}\, dx \qquad (\alpha)$$

where A is the total number of observations—positive and negative, c is a constant for the same set of observations, and x is the error. A table of values of $\int_0^{\frac{x}{c}} \epsilon^{-\frac{x^2}{c^2}}\, dx$ for different values of $\frac{x}{c}$ is given on page 22 of Airy's treatise and has been used—in combination with a more dilated table of the doubles of these integrals in Chauvenet's Astronomy, Vol. II. page 593—to find (by interpolation) values of $\frac{x}{c}$ corresponding to the known values of the integral $\frac{1}{2}-\frac{n_r}{A}$ for the case of our disturbances, in which $x = C$ the constant separating value. Again, we find (in Airy, page 19) for the sum of all the errors between $+x$ and $+\infty$

$$\frac{A}{c\sqrt{\pi}}\int_{+x}^{+\infty} \epsilon^{-\frac{x^2}{c^2}}\, x\, dx = -\frac{cA}{2\sqrt{\pi}}\left[\epsilon^{-\frac{x^2}{c^2}}\right]_x^{\infty} = \frac{cA}{2\sqrt{\pi}}\,\epsilon^{-\frac{x^2}{c^2}} \qquad (\beta)$$

When $x=o$ this becomes $\frac{cA}{2\sqrt{\pi}}$, and when $x=C$ it is $\frac{cA}{2\sqrt{\pi}}\,\epsilon^{-\frac{C^2}{c^2}}$, that is to say, the aggregate of all the positive errors is $\frac{cA}{2\sqrt{\pi}}$ and the aggregate of the positive errors which exceed C is $\frac{cA}{2\sqrt{\pi}}\,\epsilon^{-\frac{C^2}{c^2}}$. Hence the aggregate of positive errors exceeding C multiplied by $\epsilon^{+\left(\frac{C}{c}\right)^2}$ is equal to the aggregate of all the positive errors, and the proportion of positive error *per* observation is that product divided by A.

Applying the result to the case of our easterly disturbances

$$\frac{C}{2\sqrt{\pi}} = \epsilon^{+\left(\frac{C}{c}\right)^2}\frac{\Sigma E_r}{A} \qquad (\gamma)$$

or this is the average amount of easterly disturbance *per* observation. Separate calculations of this quantity have been made from the respective values of n_r, A, and ΣE_r of the hours, months or years in the several periods of variation, each result being—like its data—independent of every other. The data and results are exhibited in the following tables:—

COLABA OBSERVATORY, DISTURBANCES OF DECLINATION

CALCULATED TOTAL DISTURBANCES. OBSERVED LARGER DISTURBANCES. CALCULATED SMALLER DISTURBANCES. Plate XII.

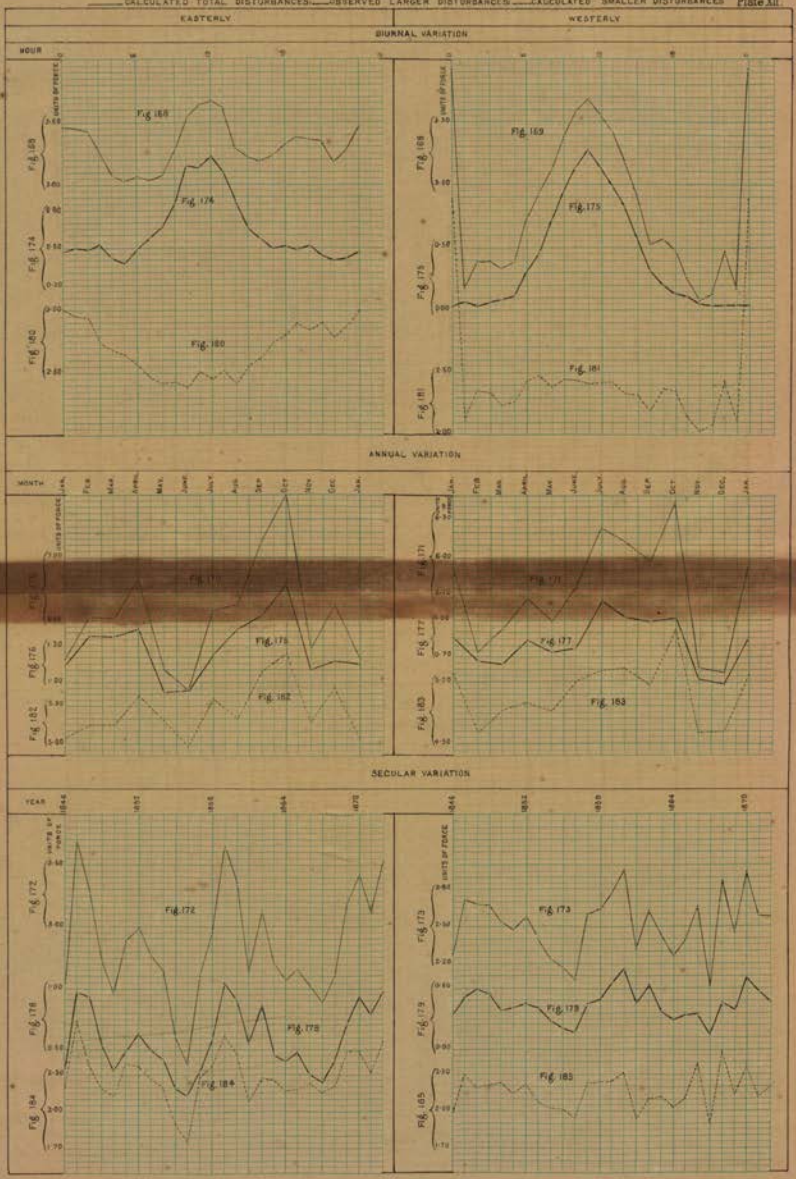

Table 46.

Disturbance diurnal variations.

Bombay Civil Hours.	EASTERLY. $A = 8220$. n_r	$\left(1-\frac{2n_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.	WESTERLY. n_r	$\left(1-\frac{2n_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.	Excess of Easterly over Westerly disturbance. Column 8 minus Column 16.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
h. m.																	
0 12	187	·955	1·42	0·46061	3·4596	2·9990	·00042088	1·04	10	·998	2·19	0·03242	3·9238	3·8914	·00047735	1·41	—·00005647
1 12	207	·950	1·39	0·50023	3·4535	2·9533	·00042014	1·04	31	·992	1·88	0·06343	2·1739	2·1105	·00026447	0·78	+·00015567
2 12	203	·951	1·39	0·49621	3·4258	2·9296	·00041676	1·03	16	·996	2·04	0·03728	2·3923	2·3550	·00029104	0·86	+·00012572
3 12	232	·944	1·35	0·52810	3·2675	2·7394	·00039750	0·99	25	·994	1·94	0·05561	2·3968	2·3412	·00029159	0·86	+·00010591
4 12	179	·956	1·42	0·41088	3·0861	2·6752	·00037544	0·93	41	·990	1·82	0·08494	2·3316	2·2467	·00028365	0·84	+·00009179
5 12	168	·959	1·44	0·38072	3·0280	2·6473	·00036837	0·91	57	·986	1·74	0·11574	2·3897	2·2740	·00029072	0·86	+·00007765
6 12	225	·945	1·35	0·49445	3·0592	2·5648	·00037217	0·92	146	·964	1·48	0·30621	2·7371	2·4309	·00033298	0·98	+·00003919
7 12	276	·933	1·29	0·57642	3·0440	2·4676	·00037031	0·92	219	·947	1·37	0·44816	2·9279	2·4797	·00035619	1·05	+·00001412
8 12	323	·921	1·24	0·66091	3·0754	2·4145	·00037414	0·93	355	·914	1·21	0·71939	3·1103	2·3909	·00037838	1·12	—·00000424
9 12	413	·900	1·16	0·85429	3·2809	2·4266	·00039914	0·99	457	·889	1·13	0·94614	3·3923	2·4462	·00041270	1·22	—·00001356
10 12	538	·869	1·06	1·15174	3·5426	2·3909	·00043097	1·07	542	·868	1·07	1·14146	3·5866	2·4451	·00043632	1·29	—·00000535
11 12	528	·872	1·08	1·13369	3·6396	2·5059	·00044277	1·10	600	·854	1·03	1·27529	3·6843	2·4090	·00044821	1·33	—·00000544
12 12	564	·863	1·05	1·21830	3·6690	2·4507	·00044635	1·11	540	·869	1·07	1·12768	3·5433	2·4156	·00043106	1·27	+·00001529
13 12	506	·877	1·09	1·10022	3·6096	2·5094	·00043913	1·09	485	·882	1·11	0·99649	3·4163	2·4198	·00041561	1·23	+·00002352
14 12	426	·896	1·15	0·87760	3·2934	2·4158	·00040066	0·99	415	·899	1·16	0·82235	3·1582	2·3359	·00038421	1·14	+·00001645
15 12	310	·925	1·26	0·65645	3·2113	2·5549	·00039067	0·97	302	·927	1·27	0·57620	2·8909	2·3147	·00035170	1·04	+·00003897
16 12	260	·937	1·31	0·57427	3·1946	2·6203	·00038863	0·96	168	·959	1·44	9·31667	2·5185	2·2018	·00030639	0·91	+·00008224
17 12	212	·948	1·37	0·49631	3·2424	2·7461	·00039446	0·98	99	·976	1·60	0·19845	2·5670	2·3686	·00031229	0·92	+·00008217
18 12	215	·948	1·37	0·50672	3·3105	2·8038	·00040274	1·00	61	·985	1·72	0·12893	2·4840	2·3551	·00030219	0·89	+·00010055
19 12	203	·951	1·39	0·49047	3·3861	2·8956	·00041194	1·02	56	·986	1·74	0·10964	2·2638	2·1542	·00027540	0·81	+·00013654
20 12	218	·947	1·37	0·51438	3·3605	2·8461	·00040882	1·02	27	·993	1·91	0·05426	2·0836	2·0293	·00025348	0·75	+·00015534
21 12	186	·955	1·42	0·44574	3·3480	2·9023	·00040730	1·01	20	·995	1·98	0·04215	2·1252	2·0831	·00025854	0·76	+·00014876
22 12	168	·959	1·44	0·40143	3·1926	2·7912	·00038840	0·96	17	·996	2·04	0·03843	2·4661	2·4277	·00030001	0·89	+·00008839
23 12	169	·959	1·44	0·41206	3·2772	2·8651	·00039869	0·99	20	·995	1·98	0·04296	2·1660	2·1230	·00026350	0·78	+·00013519
Mean...							·00040277								·00033825		

The numbers in columns 6 and 14 are curved in Figs. 168 and 169, those in columns 7 and 15 in Figs. 180 and 181, those in columns 5 and 13 in Figs. 174 and 175 (Plate XII), those in column 18 in Fig. 163 (thin-line), and those in columns 9 and 17 in Figs. 151 and 152 (Plate XI), the last being in thin lines to distinguish them from the ratios of ΣEr.

Table 47.

Disturbance annual variations.

Month.	EASTERLY. n_r	$\left(1-\frac{2n_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.	A	WESTERLY. n_r	$\left(1-\frac{2n_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
January ...	550	·934	1·30	1·14172	6·1874	5·0457	·00036935	0·92	16752	422	·950	1·39	0·85632	5·9119	5·05556	·00035291	1·02
February	604	·922	1·25	1·36599	6·5167	5·1507	·00041967	1·05	15528	321	·959	1·44	0·65962	5·2460	4·5864	·00033784	0·97
March ...	635	·923	1·25	1·36542	6·5140	5·1486	·00039681	0·99	16416	323	·961	1·46	0·64239	5·4141	4·7717	·00032981	0·95
April ...	624	·924	1·25	1·42904	6·8174	5·3884	·00041773	1·05	16320	415	·949	1·38	0·84413	5·6685	4·8244	·00034734	1·00
May ...	429	·949	1·38	0·90869	6·1021	5·1934	·00036322	0·91	16800	366	·956	1·42	0·73066	5·4881	4·7574	·00032667	0·94
June ...	457	·945	1·36	0·93215	5·9258	4·9937	·00035680	0·89	16608	376	·955	1·42	0·76708	5·7616	4·9945	·00034691	1·00
July ...	572	·933	1·30	1·21232	6·5701	5·3578	·00038395	0·96	17112	559	·935	1·30	1·15100	6·2378	5·0868	·00036453	1·05
August ...	651	·921	1·24	1·42274	6·6205	5·1978	·00039979	1·00	16560	490	·941	1·34	1·01559	6·1169	5·1013	·00036938	1·07
September.	666	·920	1·24	1·53104	7·1244	5·5934	·00042897	1·07	16608	480	·942	1·34	0·99036	5·9649	4·9745	·00035915	1·04
October ...	746	·911	1·20	1·77687	7·4996	5·7227	·00044768	1·12	16752	449	·946	1·36	1·01162	6·4310	5·4194	·00038389	1·11
November.	488	·939	1·32	1·09825	6·2721	5·1739	·00039239	0·98	15984	264	·967	1·51	0·52241	5·1078	4·5854	·00031955	0·92
December .	494	·938	1·32	1·15828	6·6148	5·4565	·00041760	1·05	15840	244	·969	1·53	0·48909	5·0818	4·5927	·00032082	0·93
Mean...							·00039950									·00034657	

The numbers in columns 6 and 15 are curved in Figs. 170 and 171, those in columns 7 and 16 in Figs. 182 and 183, those in columns 5 and 14 in Figs. 176 and 177 (Plate XII), and those in columns 9 and 18 in Figs. 153 and 154 (Plate XI), the last being in thin lines to distinguish them from the ratios of ΣEr.

TABLE 48.

Disturbance secular variations.

Year.	EASTERLY.								A	WESTERLY.							
	n_r	$\left(\frac{m_r}{1-\frac{1}{r}}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.		n_r	$\left(\frac{m_r}{1-\frac{1}{r}}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1846 ...	173	·954	1·41	0·34859	2·5452	2·1966	·00033881	0·87	7512	153	·959	1·44	0·28666	2·2799	1·9932	·00030349	0·88
1847 ...	383	·898	1·16	0·95992	3·6861	2·7266	·00049231	1·26	7488	198	·947	1·37	0·41431	2·7068	2·2925	·00036148	1·05
1848 ..	411	·889	1·13	0·91615	3·2848	2·3687	·00044293	1·14	7476	244	·934	1·30	0·49379	2·6760	2·1822	·00036084	1·05
1849 ...	268	·928	1·27	0·54568	2·7379	2·1922	·00036799	0·94	7440	224	·940	1·33	0·45335	2·6586	2·2053	·00035734	1·04
1850 ...	171	·954	1·41	0·33655	2·4573	2·1208	·00033029	0·85	7440	189	·960	1·45	0·38093	2·5290	2·2201	·00033992	0·99
1851 ...	224	·940	1·33	0·49045	2·8761	2·3857	·00038658	0·99	7440	165	·956	1·42	0·32883	2·4698	2·1410	·00033197	0·97
1852 ...	291	·922	1·25	0·62750	2·9936	2·3661	·00039978	1·03	7488	181	·952	1·40	0·36205	2·5703	2·2083	·00034325	1·00
1853 ...	235	·936	1·31	0·49679	2·7635	2·2667	·00037630	0·97	7344	168	·954	1·41	0·32786	2·3939	2·0660	·00032596	0·95
1854 ...	205	·944	1·35	0·42496	2·6293	2·2043	·00035685	0·92	7368	118	·968	1·52	0·22145	2·2318	2·0104	·00030291	0·88
1855 ...	103	·971	1·54	0·19573	2·0971	1·9014	·00029030	0·75	7224	87	·976	1·60	0·16797	2·1728	2·0048	·00030077	0·88
1856 ...	70	·980	1·64	0·12818	1·8875	1·7593	·00026391	0·68	7152	69	·981	1·66	0·13185	2·0740	1·9422	·00028999	0·84
1857 ...	149	·960	1·45	0·31734	2·5978	2·2805	·00035258	0·90	7368	174	·953	1·40	0·36441	2·5870	2·2226	·00035112	1·02
1858 ...	267	·927	1·27	0·58819	2·9511	2·3629	·00040449	1·04	7296	195	·947	1·37	0·40273	2·6311	2·2284	·00036062	1·05
1859 ...	417	·886	1·12	1·03929	3·6434	2·6041	·00049938	1·28	7296	255	·930	1·28	0·53708	2·7643	2·2272	·00037888	1·10
1860 ...	385	·895	1·15	0·89339	3·3527	2·4593	·00045802	1·18	7320	301	·918	1·23	0·65126	2·9566	2·3053	·00040391	1·18
1861 ...	262	·923	1·25	0·55178	2·6324	2·0806	·00038895	1·00	6768	188	·944	1·35	0·37422	2·3154	1·9412	·00034211	1·00
1862 ...	388	·894	1·14	0·85035	3·1189	2·2686	·00042748	1·10	7296	262	·928	1·27	0·52213	2·6197	2·0976	·00035906	1·05
1863 ...	217	·941	1·34	0·44831	2·7002	2·2519	·00036767	0·94	7344	155	·958	1·44	0·30312	2·4107	2·1076	·00032826	0·96
1864 ...	198	·946	1·36	0·40327	2·5637	2·1604	·00034794	0·89	7368	120	·967	1·51	0·23070	2·2556	2·0249	·00030614	0·89
1865 ...	232	·937	1·31	0·47034	2·6498	2·1735	·00036199	0·93	7320	134	·963	1·47	0·27395	2·3776	2·1037	·00032480	0·95
1866 ...	143	·961	1·46	0·29873	2·5177	2·2190	·00034737	0·89	7248	122	·966	1·50	0·27970	2·6536	2·3739	·00036612	1·07
1867 ...	110	·970	1·53	0·22907	2·3801	2·1510	·00032623	0·84	7296	61	·983	1·69	0·11582	2·0145	1·8987	·00027611	0·80
1868 ...	179	·947	1·37	0·39769	2·5981	2·2004	·00038801	1·00	6696	147	·956	1·42	0·38092	2·8611	2·4802	·00042728	1·24
1869 ...	297	·919	1·23	0·70085	3·1818	2·4810	·00043467	1·12	7320	157	·957	1·43	0·31657	2·4465	2·1299	·00033423	0·97
1870 ...	388	·894	1·14	0·93168	3·4172	2·4855	·00046531	1·19	7344	263	·928	1·27	0·58415	2·9308	2·3467	·00039908	1·16
1871 ...	359	·902	1·17	0·78684	3·1048	2·3150	·00042416	1·09	7320	230	·937	1·31	0·46335	2·5775	2·1742	·00035212	1·02
1872 ...	391	·894	1·14	0·95862	3·5160	2·5574	·00047720	1·23	7368	189	·949	1·38	0·38309	2·5725	2·1894	·00034915	1·02
Mean...							·00038954									·00034359	

The numbers in columns 6 and 15 are curved in Figs. 172 and 173, those in columns 7 and 16 in Figs. 184 and 185, those in columns 5 and 14 in Figs. 178 and 179 (Plate XII), and those in columns 9 and 18 in Figs. 155 and 156 (Plate XI), the last being in thin lines to distinguish them from the ratios of ΣE_r.

143. Instead of employing n_r as one of the data, we might, however, have used the constant separating value (C) in lieu of it; for equation (γ) gives us

$$log \frac{A}{2\sqrt{\pi}\,\Sigma E_r} = \frac{C^2}{c^2} log\, e - log\, c \qquad (\delta)$$

from which c may be obtained by a process of successive approximation, and thence $\frac{c}{2\sqrt{\pi}}$.

It would be interesting to compare the results of the two independent processes, and might afford a criterion for judging of the admissibility of our assumption that the disturbances follow the law of distribution of errors of observation, a close agreement being in support of the assumption and a wide divergence opposed to it, but opportunity fails for embodying the comparison in the present discussion.

144. It will be observed, from the curves of aggregates on Plate XII, that there is a general, though far from exact, similarity of movement in the annual and secular curves representing disturbances below and above the magnitude of the separating value, so that the curves of total disturbances are exaggerated copies of those of disturbances exceeding the limit. It is otherwise with the diurnal curves, for the aggregates of westerly disturbances below the limit are nearly constant throughout the day, whilst those of easterly disturbances vary in a manner the opposite (roughly speaking) to the variation of aggregates of easterly disturbances exceeding the limit. It would appear, then, that the separating value happens to be so chosen that the diurnal variation in the magnitude of westerly disturbances below the limit is counterbalanced partly by an opposite variation in the numbers of occurrences within the limit and partly by the relatively large magnitude of the disturbances corresponding to the extra occurrences. The numbers of occurrences of

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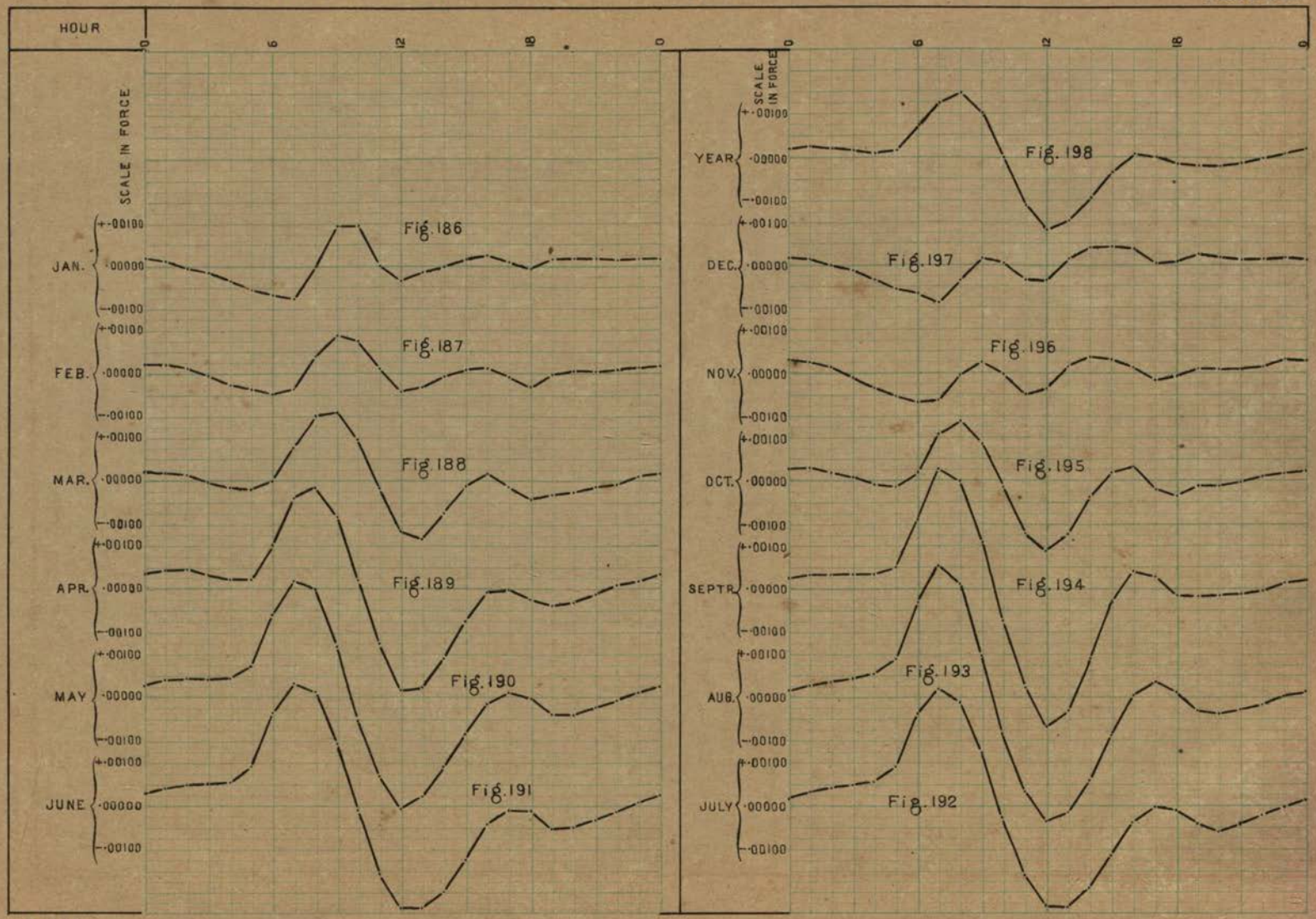
MEAN DIURNAL VARIATION OF DECLINATION FOR EACH MONTH AND FOR THE WHOLE YEAR.

Plate XIII.



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westerly disturbances above the limit between the hours 18 and 5 are too small to secure the obliteration of casual abnormalities from the corresponding aggregates, and to this is attributable the erratic form of the curve of calculated total disturbances for those hours (Fig. 169): but little significance attaches, therefore, to this part of the curve, which has a probability small in comparison with the sparseness of the observations upon which it depends. The thick line of Fig. 163 represents, for each hour, the excess of observed easterly over observed westerly disturbance *per* day for the whole period of observation: the thin line represents the excess of calculated total easterly over calculated total westerly disturbance *per* day, and the close agreement of the two curves between the hours 3 and 18 implies that, of the disturbances occurring within the limits $\pm 1'{\cdot}4$ of the normal declination, the excess of the easterly aggregates over the westerly aggregates follows the same law of variation from hour to hour as does the corresponding excess of the larger disturbances taken by themselves and, having regard to the scales of the curves, that the two excesses are of about the same magnitude: the disagreement of the two curves in the remaining hours is explained in the same way as the erratic form of Fig. 169.

The thin lines of Figs. 151 to 156 represent ratios of the calculated total disturbances *per* observation—within *and* without the limit of the separating value, and the thick line curves represent ratios of *aggregates* of the larger disturbances only.

145. Figs. 73 to 150 are constructed to show the extent to which the general character of the diurnal variation of disturbance aggregates is exhibited by individual month's or year's observations: the yearly curves further indicate that the extent of variability of disturbance at different hours follows, like the general aggregates of disturbance, the sun-spot period,—being great when the spotted area is great and small when this is small.

146. *The regular solar-diurnal variation.*—After the separation of disturbed observations differing from the final normals by $1'{\cdot}4$, the averages were taken of the monthly final normals of the twenty-four hours—in the first place for every month, and in the second place for each of the fifty-four half-years; and by means of these averages were calculated the diurnal variations* for each month (on an average of twenty-seven years), for the whole year, and for each individual half year from 1846 to 1872, the one half-year comprising the months April to September, and the other the months January to March and October to December. The diurnal variations are shown in the following tables.

TABLE 49.—*Showing, for the period* 1846 *to* 1872, *the mean-diurnal variation of Declination for each month of the year and for the whole year.*†

Bombay Civil Hours.		January.	February.	March.	April.	May.	June.	July.	August.	Septr.	October.	Novr.	Decr.	Year.
h.	m.													
0	12	+·00016	+·00020	+·00017	+·00033	+·00025	+·00026	+·00017	+·00017	+·00026	+·00027	+·00031	+·00021	+·00023
1	12	+·00009	+·00016	+·00015	+·00040	+·00038	+·00038	+·00035	+·00029	+·00033	+·00030	+·00027	+·00015	+·00027
2	12	−·00006	+·00009	+·00008	+·00042	+·00041	+·00047	+·00044	+·00037	+·00035	+·00020	+·00016	+·00001	+·00024
3	12	−·00020	−·00005	−·00007	+·00028	+·00038	+·00049	+·00050	+·00044	+·00034	+·00007	−·00007	−·00009	+·00017
4	12	−·00040	−·00028	−·00018	+·00017	+·00042	+·00053	+·00059	+·00054	+·00036	−·00007	−·00029	−·00031	+·00009
5	12	−·00058	−·00041	−·00022	+·00020	+·00072	+·00089	+·00095	+·00092	+·00053	−·00016	−·00049	−·00053	+·00015
6	12	−·00071	−·00052	−·00003	+·00100	+·00189	+·00213	+·00217	+·00220	+·00166	+·00022	−·00066	−·00064	+·00073
7	12	−·00077	−·00040	+·00076	+·00207	+·00264	+·00278	+·00274	+·00305	+·00278	+·00108	−·00059	−·00086	+·00127
8	12	·00000	+·00037	+·00148	+·00234	+·00248	+·00257	+·00243	+·00263	+·00250	+·00143	−·00001	−·00032	+·00149
9	12	+·00094	+·00087	+·00156	+·00169	+·00117	+·00145	+·00123	+·00099	+·00113	+·00088	+·00027	+·00022	+·00103
10	12	+·00093	+·00073	+·00097	+·00019	−·00053	−·00011	−·00026	−·00053	−·00072	−·00016	+·00001	+·00004	+·00002
11	12	·00000	+·00007	−·00019	−·00125	−·00182	−·00155	−·00158	−·00216	−·00226	−·00118	−·00047	−·00030	−·00106
12	12	−·00039	−·00045	−·00117	−·00232	−·00260	−·00247	−·00229	−·00283	−·00314	−·00160	−·00031	−·00030	−·00166
13	12	−·00015	−·00033	−·00134	−·00226	−·00228	−·00244	−·00235	−·00265	−·00276	−·00120	+·00019	+·00021	−·00145
14	12	−·00001	−·00006	−·00076	−·00161	−·00161	−·00200	−·00191	−·00194	−·00153	−·00035	+·00040	+·00045	−·00091
15	12	+·00013	+·00006	−·00012	−·00075	−·00082	−·00124	−·00111	−·00083	−·00028	+·00023	+·00035	+·00046	−·00033
16	12	+·00025	+·00009	+·00017	−·00008	·00016	−·00045	−·00040	+·00003	+·00044	+·00035	+·00016	+·00037	+·00006
17	12	+·00007	−·00010	−·00017	·00000	+·00010	−·00010	·00000	+·00038	+·00032	−·00019	−·00012	+·00005	+·00002
18	12	−·00005	−·00031	−·00045	−·00025	−·00003	−·00009	−·00005	+·00016	−·00013	−·00032	−·00002	+·00010	−·00012
19	12	+·00014	−·00002	−·00031	−·00039	−·00040	−·00053	−·00043	−·00028	−·00014	−·00011	+·00015	+·00027	−·00017
20	12	+·00016	+·00005	−·00024	−·00031	−·00041	−·00049	−·00056	−·00033	−·00011	−·00005	+·00013	+·00022	−·00016
21	12	+·00015	+·00006	−·00011	−·00012	−·00024	−·00035	−·00040	−·00024	−·00006	−·00001	+·00011	+·00016	−·00009
22	12	+·00013	+·00007	−·00005	+·00005	−·00007	−·00017	−·00021	−·00012	−·00001	+·00013	+·00021	+·00020	+·00001
23	12	+·00016	+·00014	+·00008	+·00020	+·00011	+·00005	−·00001	−·00004	+·00016	+·00024	+·00033	+·00022	+·00012

These variations are also represented by the curves of Figs. 186 to 198, which show great similarity of character for the six summer months, and a gradual change to a type of curve nearly approaching to that of a magnetic equatorial station in the months November and December, with a reverse change after these months.

* By diurnal or annual variation is always to be understood the series of hourly or monthly values expressed by the excess of each above the mean value for the whole day or for the whole year respectively, or rather, by these values converted into force.

† In this and all the Tables that follow, the positive sign indicates a movement of the north end of the declination magnet to the eastward of its normal direction, and the deviations from the normal are expressed in *mm-mg-s* units of force.

Table 50.

Showing, for the half years including the months from April to September in the several years 1846 *to* 1872, *and in the whole period of twenty-seven years, the mean diurnal variation of Declination.*

Bombay Civil Hours.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.														
0 12 ...	+ ·00018	+ ·00017	+ ·00028	+ ·00022	+ ·00028	+ ·00028	+ ·00029	+ ·00030	+ ·00037	+ ·00029	+ ·00031	+ ·00027	+ ·00025	+ ·00019
1 12 ...	+ ·00028	+ ·00023	+ ·00038	+ ·00032	+ ·00041	+ ·00034	+ ·00038	+ ·00041	+ ·00045	+ ·00040	+ ·00043	+ ·00039	+ ·00040	+ ·00032
2 12 ...	+ ·00031	+ ·00028	+ ·00035	+ ·00032	+ ·00043	+ ·00036	+ ·00045	+ ·00047	+ ·00054	+ ·00048	+ ·00046	+ ·00047	+ ·00043	+ ·00030
3 12 ...	+ ·00032	+ ·00025	+ ·00031	+ ·00030	+ ·00039	+ ·00031	+ ·00042	+ ·00054	+ ·00051	+ ·00045	+ ·00050	+ ·00047	+ ·00047	+ ·00030
4 12 ...	+ ·00037	+ ·00040	+ ·00030	+ ·00036	+ ·00037	+ ·00034	+ ·00050	+ ·00060	+ ·00046	+ ·00054	+ ·00052	+ ·00047	+ ·00049	+ ·00032
5 12 ...	+ ·00061	+ ·00078	+ ·00057	+ ·00068	+ ·00060	+ ·00051	+ ·00068	+ ·00092	+ ·00068	+ ·00063	+ ·00069	+ ·00069	+ ·00076	+ ·00063
6 12 ...	+ ·00174	+ ·00185	+ ·00194	+ ·00201	+ ·00184	+ ·00151	+ ·00188	+ ·00215	+ ·00167	+ ·00146	+ ·00153	+ ·00160	+ ·00186	+ ·00211
7 12 ...	+ ·00265	+ ·00254	+ ·00302	+ ·00291	+ ·00280	+ ·00245	+ ·00263	+ ·00288	+ ·00227	+ ·00227	+ ·00212	+ ·00242	+ ·00273	+ ·00300
8 12 ...	+ ·00249	+ ·00245	+ ·00292	+ ·00270	+ ·00266	+ ·00232	+ ·00246	+ ·00238	+ ·00213	+ ·00215	+ ·00199	+ ·00232	+ ·00252	+ ·00306
9 12 ...	+ ·00139	+ ·00102	+ ·00146	+ ·00148	+ ·00145	+ ·00133	+ ·00113	+ ·00098	+ ·00101	+ ·00119	+ ·00096	+ ·00119	+ ·00131	+ ·00180
10 12 ...	- ·00048	- ·00056	- ·00034	- ·00024	- ·00020	- ·00001	- ·00045	- ·00073	- ·00057	- ·00014	- ·00039	- ·00055	- ·00045	- ·00015
11 12 ...	- ·00183	- ·00177	- ·00205	- ·00170	- ·00181	- ·00148	- ·00179	- ·00217	- ·00165	- ·00148	- ·00153	- ·00150	- ·00187	- ·00177
12 12 ...	- ·00256	- ·00251	- ·00285	- ·00289	- ·00270	- ·00234	- ·00259	- ·00294	- ·00230	- ·00229	- ·00223	- ·00229	- ·00269	- ·00291
13 12 ...	- ·00247	- ·00232	- ·00257	- ·00261	- ·00271	- ·00228	- ·00242	- ·00260	- ·00227	- ·00217	- ·00206	- ·00213	- ·00257	- ·00281
14 12 ...	- ·00175	- ·00156	- ·00192	- ·00186	- ·00195	- ·00165	- ·00171	- ·00180	- ·00148	- ·00159	- ·00140	- ·00146	- ·00193	- ·00219
15 12 ...	- ·00090	- ·00068	- ·00082	- ·00078	- ·00091	- ·00078	- ·00080	- ·00079	- ·00068	- ·00085	- ·00064	- ·00063	- ·00100	- ·00119
16 12 ..	·00000	+ ·00018	- ·00010	- ·00004	- ·00014	- ·00011	- ·00012	- ·00012	- ·00008	- ·00019	- ·00004	- ·00006	- ·00021	- ·00015
17 12 ...	+ ·00029	+ ·00026	+ ·00009	+ ·00014	+ ·00016	+ ·00009	+ ·00007	+ ·00020	+ ·00002	- ·00001	+ ·00003	- ·00001	+ ·00013	+ ·00007
18 12 ...	+ ·00012	+ ·00007	- ·00002	- ·00015	- ·00007	- ·00006	- ·00011	+ ·00001	- ·00022	- ·00019	- ·00022	- ·00045	+ ·00001	- ·00001
19 12 ...	- ·00027	- ·00035	- ·00036	- ·00047	- ·00039	- ·00038	- ·00035	- ·00033	- ·00043	- ·00040	- ·00043	- ·00049	- ·00030	·00034
20 12 ...	- ·00032	- ·00039	- ·00033	- ·00040	- ·00039	- ·00043	- ·00035	- ·00029	- ·00041	- ·00036	- ·00039	- ·00048	- ·00030	- ·00032
21 12 ...	- ·00014	- ·00024	- ·00028	- ·00026	- ·00020	- ·00030	- ·00023	- ·00020	- ·00022	- ·00022	- ·00025	- ·00023	- ·00015	- ·00016
22 12 ...	- ·00013	- ·00012	- ·00011	- ·00009	- ·00004	- ·00010	- ·00005	- ·00004	- ·00001	- ·00008	- ·00008	- ·00009	- ·00002	- ·00010
23 12 ...	+ ·00010	+ ·00005	+ ·00011	+ ·00006	+ ·00013	+ ·00010	+ ·00008	+ ·00017	+ ·00021	+ ·00010	+ ·00012	+ ·00014	+ ·00013	+ ·00001
Range ...	·00521	·00505	·00587	·00580	·00551	·00479	·00522	·00582	·00457	·00456	·00435	·00471	·00542	·00597

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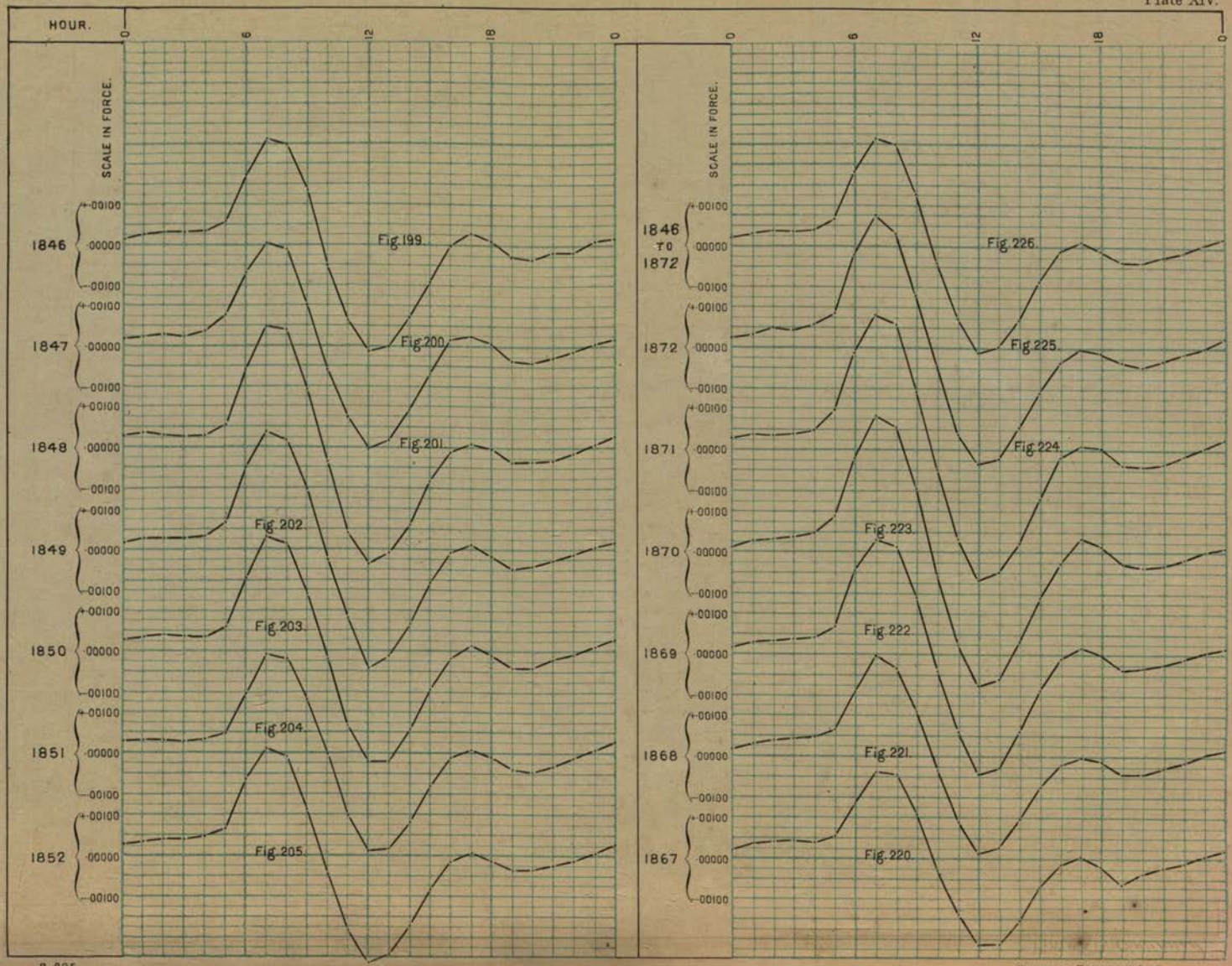
MEAN DIURNAL VARIATION OF DECLINATION FOR THE HALF YEAR APRIL TO SEPTEMBER IN EACH OF THE YEARS 1846 TO 1872 AND IN THE WHOLE PERIOD OF 27 YEARS.

Plate XIV.



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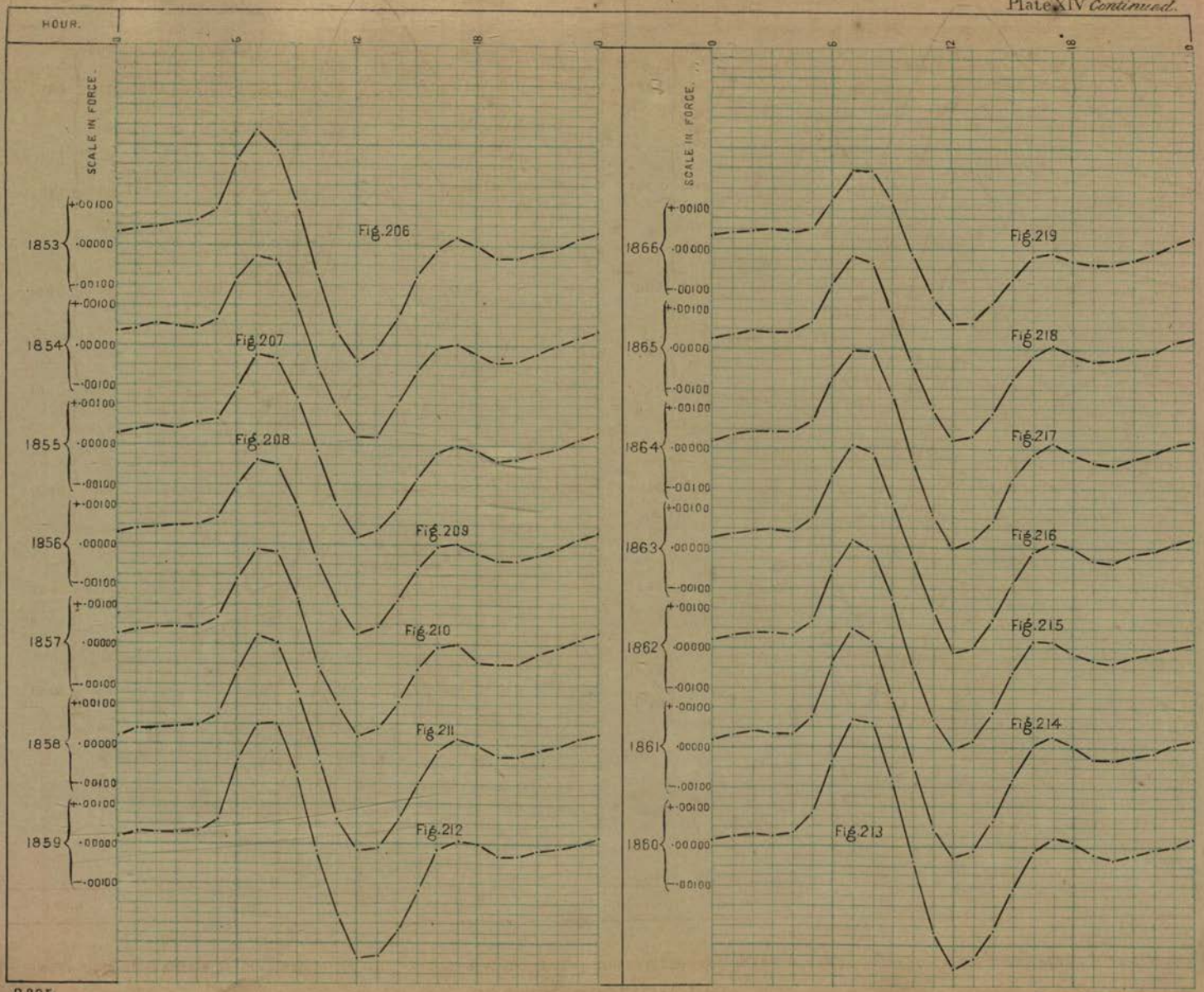

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Government Photo-Lithographic Office Plume 1884.

TABLE 50—*continued.*

Bombay Civil Hours.			1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	Twenty-seven years 1846 to 1872.
h.	m.															
0	12	...	+ ·00018	+ ·00018	+ ·00017	+ ·00027	+ ·00020	+ ·00026	+ ·00031	+ ·00025	+ ·00021	+ ·00017	+ ·00013	+ ·00030	+ ·00025	+ ·00024
1	12	...	+ ·00028	+ ·00032	+ ·00033	+ ·00036	+ ·00036	+ ·00036	+ ·00042	+ ·00039	+ ·00031	+ ·00032	+ ·00030	+ ·00039	+ ·00035	+ ·00036
2	12	...	+ ·00030	+ ·00041	+ ·00038	+ ·00045	+ ·00045	+ ·00048	+ ·00047	+ ·00047	+ ·00039	+ ·00035	+ ·00036	+ ·00038	+ ·00051	+ ·00041
3	12	...	+ ·00024	+ ·00035	+ ·00038	+ ·00047	+ ·00044	+ ·00042	+ ·00049	+ ·00048	+ ·00042	+ ·00039	+ ·00041	+ ·00042	+ ·00047	+ ·00040
4	12	...	+ ·00032	+ ·00035	+ ·00032	+ ·00043	+ ·00044	+ ·00043	+ ·00043	+ ·00044	+ ·00050	+ ·00043	+ ·00050	+ ·00051	+ ·00056	+ ·00043
5	12	...	+ ·00081	+ ·00076	+ ·00067	+ ·00074	+ ·00066	+ ·00066	+ ·00049	+ ·00056	+ ·00067	+ ·00073	+ ·00092	+ ·00099	+ ·00088	+ ·00070
6	12	...	+ ·00216	+ ·00207	+ ·00193	+ ·00177	+ ·00174	+ ·00158	+ ·00122	+ ·00141	+ ·00162	+ ·00205	+ ·00232	+ ·00241	+ ·00232	+ ·00184
7	12	...	+ ·00319	+ ·00298	+ ·00269	+ ·00253	+ ·00246	+ ·00233	+ ·00194	+ ·00215	+ ·00248	+ ·00287	+ ·00336	+ ·00332	+ ·00327	+ ·00268
8	12	...	+ ·00310	+ ·00261	+ ·00240	+ ·00237	+ ·00242	+ ·00217	+ ·00192	+ ·00206	+ ·00219	+ ·00265	+ ·00306	+ ·00308	+ ·00281	+ ·00250
9	12	...	+ ·00167	+ ·00123	+ ·00119	+ ·00108	+ ·00134	+ ·00097	+ ·00122	+ ·00110	+ ·00113	+ ·00147	+ ·00157	+ ·00147	+ ·00129	+ ·00128
10	12	...	− ·00037	− ·00049	− ·00051	− ·00025	− ·00034	− ·00040	− ·00013	− ·00025	− ·00030	− ·00039	− ·00055	− ·00047	− ·00047	− ·00038
11	12	...	− ·00217	− ·00206	− ·00180	− ·00157	− ·00168	− ·00152	− ·00118	− ·00141	− ·00159	− ·00190	− ·00225	− ·00214	− ·00209	− ·00177
12	12	...	− ·00308	− ·00278	− ·00253	− ·00265	− ·00250	− ·00228	− ·00192	− ·00216	− ·00235	− ·00292	− ·00324	− ·00318	− ·00286	− ·00261
13	12	...	− ·00282	− ·00262	− ·00243	− ·00248	− ·00229	− ·00218	− ·00187	− ·00205	− ·00219	− ·00275	− ·00306	− ·00297	− ·00269	− ·00246
14	12	...	− ·00214	− ·00188	− ·00162	− ·00178	− ·00182	− ·00166	− ·00135	− ·00150	− ·00150	− ·00185	− ·00215	− ·00225	− ·00195	− ·00177
15	12	...	− ·00107	− ·00083	− ·00065	− ·00084	− ·00077	− ·00074	− ·00075	− ·00070	− ·00073	− ·00085	− ·00106	− ·00117	− ·00107	− ·00084
16	12	...	− ·00013	+ ·00002	+ ·00016	− ·00009	− ·00012	− ·00018	− ·00021	− ·00011	− ·00016	− ·00006	− ·00025	− ·00016	− ·00034	− ·00010
17	12	...	+ ·00024	+ ·00028	+ ·00015	+ ·00013	+ ·00011	+ ·00007	− ·00011	+ ·00005	+ ·00001	+ ·00022	+ ·00038	+ ·00015	− ·00002	+ ·00012
18	12	...	+ ·00018	+ ·00003	− ·00012	− ·00001	− ·00012	− ·00014	− ·00027	− ·00012	− ·00008	+ ·00002	+ ·00019	+ ·00007	− ·00010	− ·00007
19	12	...	− ·00022	− ·00032	− ·00035	− ·00029	− ·00034	− ·00031	− ·00042	− ·00059	− ·00041	− ·00035	− ·00025	− ·00036	− ·00036	− ·00037
20	12	...	− ·00030	− ·00034	− ·00041	− ·00038	− ·00039	− ·00027	− ·00041	− ·00033	− ·00039	− ·00031	− ·00033	− ·00039	− ·00047	− ·00037
21	12	...	− ·00022	− ·00023	− ·00024	− ·00019	− ·00023	− ·00017	− ·00027	− ·00020	− ·00027	− ·00022	− ·00030	− ·00032	− ·00030	− ·00023
22	12	...	− ·00007	− ·00011	− ·00011	− ·00008	− ·00009	− ·00005	− ·00009	− ·00008	− ·00010	− ·00008	− ·00015	− ·00012	− ·00013	− ·00009
23	12	...	·00000	+ ·00008	− ·00001	+ ·00009	+ ·00008	+ ·00017	+ ·00012	+ ·00011	+ ·00007	+ ·00005	+ ·00002	+ ·00007	+ ·00002	+ ·00009
Range		...	·00627	·00576	·00522	·00518	·00496	·00461	·00386	·00425	·00483	·00579	·00660	·00650	·00607	·00529

Curves representing these variations are numbered 199 to 226 on Plate XIV.

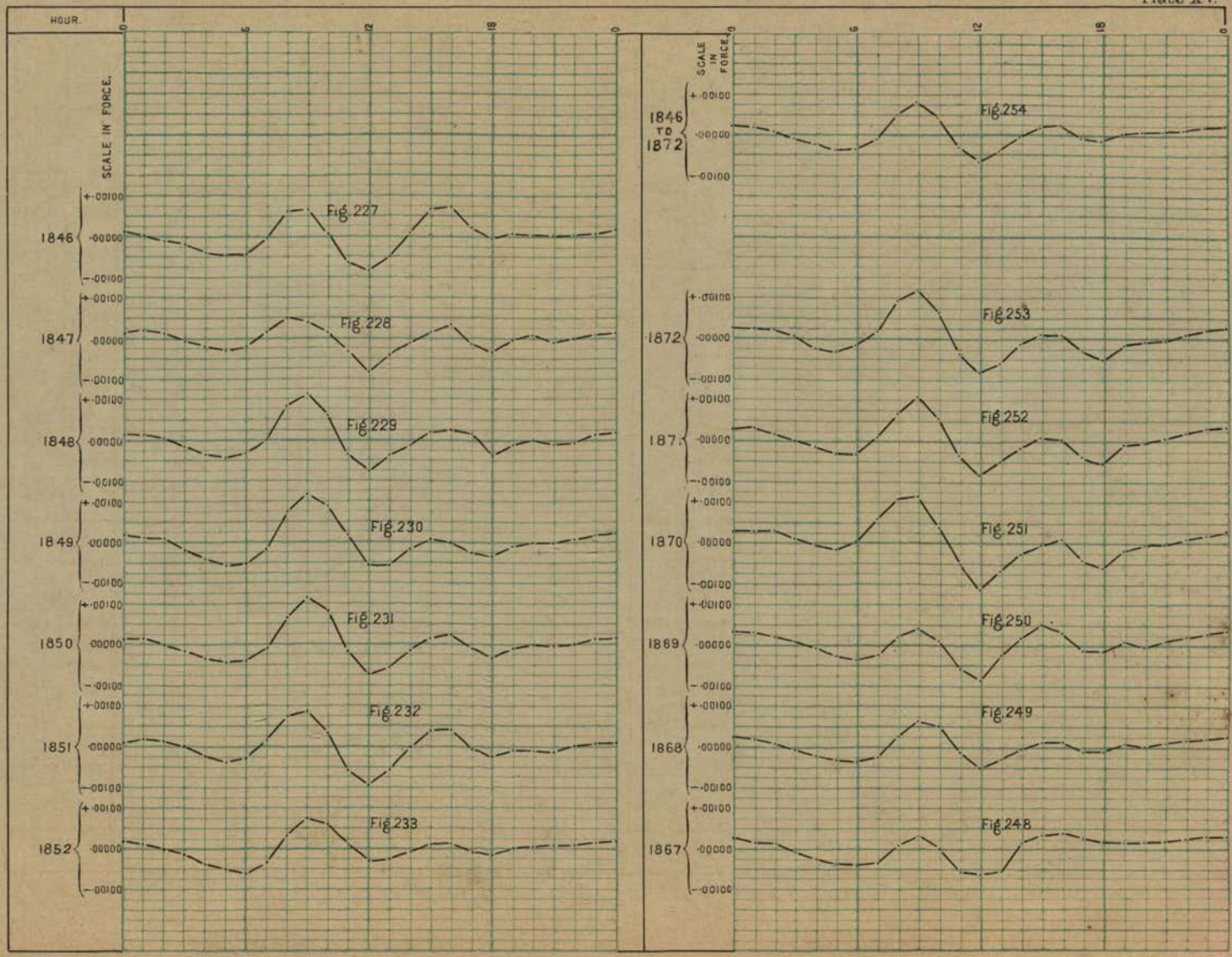
TABLE 51.—*Showing, for the half-years including the months from January to March and October to December in the several years* 1846 *to* 1872, *and in the whole period of twenty-seven years, the mean-diurnal variation of Declination.*

Bombay Civil Hours.		1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h.	m.														
0	12	+·00015	+·00013	+·00018	+·00022	+·00013	+·00011	+·00021	+·00026	+·00034	+·00023	+·00020	+·00018	+·00026	+·00017
1	12	+·00003	+·00022	+·00017	+·00013	+·00014	+·00020	+·00013	+·00021	+·00027	+·00016	+·00013	+·00007	+·00018	+·00017
2	12	−·00008	+·00012	+·00004	+·00010	+·00001	+·00014	−·00001	+·00004	+·00017	+·00007	+·00006	−·00009	+·00005	+·00008
3	12	−·00020	−·00003	−·00012	−·00021	−·00016	−·00001	−·00016	−·00010	−·00005	−·00008	−·00008	−·00019	−·00013	−·00006
4	12	−·00037	−·00020	−·00035	−·00044	−·00033	−·00023	−·00037	−·00027	−·00025	−·00023	−·00026	−·00031	−·00031	−·00030
5	12	−·00046	−·00028	−·00046	−·00056	−·00046	−·00037	−·00050	−·00044	−·00041	−·00044	−·00041	−·00047	−·00057	−·00025
6	12	−·00044	−·00022	−·00030	−·00051	−·00038	−·00026	−·00061	−·00051	−·00054	−·00039	−·00049	−·00053	−·00056	−·00039
7	12	−·00002	+·00018	·00000	−·00015	−·00005	+·00016	−·00030	−·00047	−·00039	−·00021	−·00026	−·00024	−·00025	−·00019
8	12	+·00062	+·00075	+·00082	+·00074	+·00066	+·00074	+·00036	+·00006	+·00014	+·00036	+·00040	+·00038	+·00057	+·00081
9	12	+·00065	+·00063	+·00116	+·00119	+·00118	+·00088	+·00076	+·00037	+·00036	+·00062	+·00062	+·00076	+·00119	+·00133
10	12	+·00008	+·00038	+·00060	+·00091	+·00078	+·00033	+·00061	+·00018	+·00015	+·00010	+·00014	+·00048	+·00084	+·00082
11	12	−·00062	−·00030	−·00034	+·00019	−·00018	−·00055	+·00011	−·00027	−·00039	−·00059	−·00043	−·00002	+·00001	−·00015
12	12	−·00083	−·00083	−·00075	−·00056	−·00073	−·00096	−·00031	−·00051	−·00064	−·00077	−·00069	−·00028	−·00048	−·00053
13	12	−·00049	−·00046	−·00038	−·00055	−·00054	−·00052	−·00023	−·00028	−·00042	−·00046	−·00031	−·00021	−·00041	−·00044
14	12	+·00009	−·00008	−·00014	−·00015	−·00014	+·00001	−·00003	+·00008	−·00010	−·00010	+·00007	−·00013	−·00019	−·00014
15	12	+·00066	+·00015	+·00023	+·00007	+·00014	+·00038	+·00010	+·00032	+·00021	+·00017	+·00030	+·00003	−·00004	−·00001
16	12	+·00074	+·00029	+·00025	+·00001	+·00024	+·00042	+·00012	+·00032	+·00035	+·00030	+·00030	+·00013	−·00004	−·00008
17	12	+·00023	−·00015	−·00018	−·00024	−·00009	−·00004	−·00005	+·00019	+·00017	+·00016	+·00009	−·00001	−·00028	−·00044
18	12	−·00003	−·00035	−·00038	−·00034	−·00029	−·00025	−·00015	+·00002	+·00007	+·00014	+·00002	−·00005	−·00029	−·00058
19	12	+·00008	−·00002	−·00009	−·00006	−·00006	−·00005	−·00001	+·00011	+·00008	+·00015	+·00007	+·00002	+·00001	−·00008
20	12	+·00005	+·00004	+·00001	·00000	·00000	−·00007	+·00003	+·00012	+·00016	+·00016	+·00007	+·00003	+·00001	+·00001
21	12	+·00005	−·00003	−·00009	+·00001	−·00001	−·00013	+·00007	+·00015	+·00020	+·00019	+·00013	+·00006	+·00007	−·00002
22	12	+·00006	+·00001	−·00004	+·00004	+·00001	+·00002	+·00007	+·00013	+·00024	+·00021	+·00015	+·00015	+·00013	+·00008
23	12	+·00006	+·00008	+·00013	+·00019	+·00012	+·00005	+·00017	+·00025	+·00027	+·00023	+·00019	+·00023	+·00024	+·00019
Range ...		·00157	·00158	·00191	·00175	·00191	·00184	·00137	·00088	·00100	·00139	·00131	·00129	·00176	·00191

COLABA OBSERVATORY.

MEAN DIURNAL VARIATION OF DECLINATION FOR THE HALF YEAR OCTOBER TO MARCH IN EACH OF THE YEARS 1846 TO 1872 AND IN THE WHOLE PERIOD OF 27 YEARS.

Plate XV.



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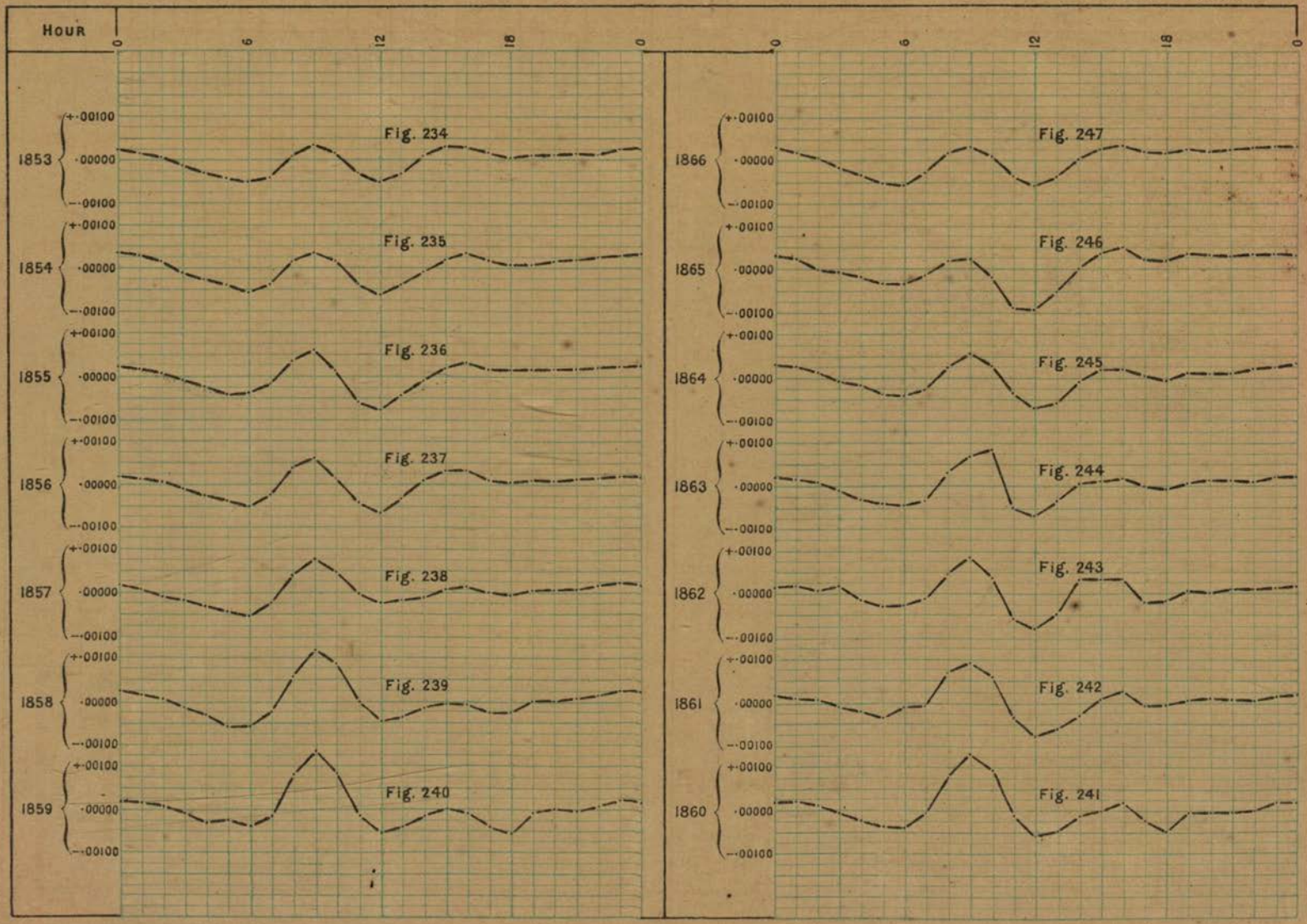
Government Photographic Office Poona 1894.


HOUR
0
6
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18
0
1853
+·00100
·00000
−·00100
Fig. 234
1854
Fig. 235
1855
Fig. 236
1856
Fig. 237
1857
Fig. 238
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Fig. 239
1859
Fig. 240
1866
Fig. 247
1865
Fig. 246
1864
Fig. 245
1863
Fig. 244
1862
Fig. 243
1861
Fig. 242
1860
Fig. 241

TABLE 51—*continued.*

Bombay Civil Hours.		1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	Twenty-seven years 1846 to 1872.
h,	m.														
0	12	+·00015	+·00017	+·00013	+·00021	+·00031	+·00027	+·00030	+·00027	+·00025	+·00034	+·00028	+·00030	+·00024	+·00022
1	12	+·00017	+·00011	+·00015	+·00017	+·00025	+·00023	+·00021	+·00019	+·00019	+·00032	+·00027	+·00032	+·00023	+·00019
2	12	+·00008	+·00006	+·00006	+·00007	+·00013	−·00002	+·00003	+·00013	+·00009	+·00021	+·00030	+·00016	+·00020	+·00008
3	12	−·00006	−·00009	+·00018	−·00009	−·00004	−·00008	−·00016	−·00007	−·00004	+·00008	+·00011	·00000	+·00002	−·00007
4	12	−·00026	−·00023	−·00017	−·00029	−·00015	−·00018	−·00033	−·00026	−·00024	−·00010	−·00006	−·00013	−·00023	−·00025
5	12	−·00043	−·00039	−·00034	−·00042	−·00039	−·00034	−·00052	−·00039	−·00036	−·00028	−·00018	−·00030	−·00035	−·00040
6	12	−·00046	−·00011	−·00029	−·00046	−·00042	−·00035	−·00056	−·00042	−·00039	−·00038	·00000	−·00033	−·00019	−·00039
7	12	−·00006	−·00006	−·00015	−·00035	−·00028	−·00014	−·00027	−·00038	−·00026	−·00026	+·00056	+·00007	+·00016	−·00013
8	12	+·00074	+·00065	+·00046	+·00028	+·00023	+·00018	+·00018	+·00006	+·00024	+·00019	+·00105	+·00065	+·00095	+·00049
9	12	+·00130	+·00093	+·00084	+·00069	+·00056	+·00023	+·00029	+·00036	+·00064	+·00040	+·00113	+·00107	+·00117	+·00079
10	12	+·00093	+·00055	+·00033	+·00083	+·00026	−·00020	+·00007	·00000	+·00050	+·00006	+·00038	+·00059	+·00064	+·00042
11	12	−·00015	−·00038	−·00060	−·00049	−·00038	−·00089	−·00035	−·00060	−·00015	−·00058	−·00053	−·00035	−·00037	−·00035
12	12	−·00060	−·00080	−·00081	−·00071	−·00072	−·00095	−·00061	−·00067	−·00050	−·00087	−·00119	−·00085	−·00085	−·00070
13	12	−·00049	−·00063	−·00048	−·00036	−·00036	−·00052	−·00040	−·00055	−·00029	−·00025	−·00066	−·00051	−·00059	−·00044
14	12	−·00017	−·00031	+·00029	+·00003	−·00009	·00000	+·00001	+·00014	−·00002	+·00018	−·00027	−·00015	−·00013	−·00005
15	12	−·00002	+·00008	+·00031	+·00014	+·00017	+·00036	+·00024	+·00035	+·00009	+·00051	−·00004	+·00007	+·00007	+·00018
16	12	+·00014	+·00024	+·00033	+·00021	+·00021	+·00050	+·00032	+·00039	+·00010	+·00027	+·00006	+·00004	+·00006	+·00023
17	12	−·00025	−·00010	−·00023	−·00001	+·00003	+·00020	+·00021	+·00026	−·00013	−·00014	−·00046	−·00041	−·00036	−·00008
18	12	−·00050	−·00005	−·00020	−·00008	−·00004	+·00018	+·00015	+·00018	−·00012	−·00017	−·00062	−·00057	−·00052	−·00018
19	12	−·00008	+·00002	+·00001	+·00003	+·00009	+·00032	+·00024	+·00016	+·00003	+·00004	−·00021	−·00010	−·00018	+·00002
20	12	−·00004	+·00010	−·00001	+·00011	+·00010	+·00028	+·00019	+·00016	·00000	−·00005	−·00007	−·00004	−·00010	+·00005
21	12	−·00004	+·00007	+·00005	+·00013	+·00011	+·00027	+·00022	+·00019	+·00007	+·00007	−·00004	+·00002	−·00008	+·00006
22	12	−·00002	+·00005	+·00007	+·00011	+·00020	+·00030	+·00027	+·00026	+·00012	+·00017	+·00006	+·00015	+·00007	+·00011
23	12	+·00015	+·00014	+·00011	+·00021	+·00023	+·00033	+·00030	+·00029	+·00020	+·00025	+·00017	+·00027	+·00018	+·00019
Range...		·00190	·00173	·00165	·00154	·00128	·00145	·00093	·00106	·00114	·00138	·00232	·00192	·00202	·00149

Curves representing these variations are numbered 227 to 254 on Plate XV.

147. Viewed together with the curves for April to September, they show very distinctly the consistent character of the semi-annual inequality in the diurnal variation of declination in different years.

The half-excess for each hour of the numbers in the last column of Table 50 over those in the last column of Table 51 or the semi-annual inequality of the mean diurnal variation of declination, is as follows, the excesses being written in the order of the hours 0 to 23 :—

+·00001, +·00003, +·00016, +·00024, +·00034, +·00055, +·00111, +·00138, +·00100, +·00024, −·00004, −·00071,
−·00095, −·00101, −·00086, −·00051, −·00016, +·00010, +·00005, −·00019, −·00021, −·00014, −·00010, −·00005.

TABLE 52.—*Showing the mean diurnal variation of Declination for each of the years* 1846 *to* 1872.

Bombay Civil Hours.		1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h.	m.														
0	12	+·00016	+·00015	+·00023	+·00022	+·00020	+·00019	+·00025	+·00028	+·00035	+·00026	+·00025	+·00022	+·00025	+·00018
1	12	+·00015	+·00022	+·00027	+·00022	+·00027	+·00027	+·00025	+·00031	+·00036	+·00028	+·00028	+·00023	+·00029	+·00024
2	12	+·00011	+·00020	+·00019	+·00021	+·00022	+·00025	+·00022	+·00025	+·00035	+·00027	+·00026	+·00019	+·00024	+·00019
3	12	+·00006	+·00011	+·00009	+·00004	+·00011	+·00015	+·00013	+·00022	+·00023	+·00018	+·00021	+·00014	+·00017	+·00012
4	12	·00000	+·00010	−·00002	−·00004	+·00002	+·00005	+·00006	+·00016	+·00010	+·00015	+·00013	+·00008	+·00009	+·00001
5	12	+·00007	+·00025	+·00005	+·00006	+·00007	+·00007	+·00009	+·00024	+·00013	+·00009	+·00014	+·00011	+·00009	+·00019
6	12	+·00065	+·00081	+·00082	+·00075	+·00073	+·00062	+·00063	+·00082	+·00056	+·00053	+·00052	+·00053	+·00065	+·00086
7	12	+·00131	+·00136	+·00151	+·00138	+·00137	+·00130	+·00116	+·00123	+·00094	+·00103	+·00093	+·00109	+·00124	+·00140
8	12	+·00155	+·00160	+·00187	+·00172	+·00166	+·00153	+·00141	+·00122	+·00113	+·00125	+·00119	+·00135	+·00154	+·00193
9	12	+·00102	+·00082	+·00131	+·00133	+·00131	+·00110	+·00094	+·00067	+·00068	+·00090	+·00079	+·00097	+·00125	+·00156
10	12	−·00020	−·00009	+·00013	+·00033	+·00029	+·00016	+·00008	−·00027	−·00021	−·00002	−·00012	−·00003	+·00019	+·00033
11	12	−·00122	−·00103	−·00119	−·00075	−·00099	−·00101	−·00084	−·00122	−·00102	−·00103	−·00098	−·00076	−·00093	−·00096
12	12	−·00169	−·00167	−·00180	−·00172	−·00171	−·00165	−·00145	−·00172	−·00147	−·00153	−·00146	−·00128	−·00158	−·00172
13	12	−·00148	−·00139	−·00147	−·00158	−·00162	−·00140	−·00132	−·00144	−·00134	−·00131	−·00118	−·00117	−·00149	−·00162
14	12	−·00083	−·00082	−·00103	−·00100	−·00104	−·00082	−·00087	−·00086	−·00079	−·00084	−·00066	−·00079	−·00106	−·00116
15	12	−·00012	−·00026	−·00029	−·00035	−·00038	−·00020	−·00035	−·00023	−·00023	−·00034	−·00017	−·00030	−·00052	−·00060
16	12	+·00037	+·00023	+·00007	−·00001	+·00005	+·00015	·00000	+·00010	+·00013	+·00005	+·00013	+·00003	−·00012	−·00011
17	12	+·00026	+·00005	−·00004	−·00005	+·00003	+·00002	+·00001	+·00019	+·00009	+·00007	+·00006	−·00001	−·00007	−·00018
18	12	+·00004	−·00014	−·00020	−·00024	−·00018	−·00015	−·00013	+·00001	−·00007	−·00002	−·00010	−·00025	−·00014	−·00029
19	12	−·00009	−·00018	−·00022	−·00026	−·00022	−·00021	−·00018	−·00011	−·00017	−·00012	−·00018	−·00023	−·00014	−·00021
20	12	−·00013	−·00017	−·00016	−·00020	−·00019	−·00025	−·00016	−·00008	−·00012	−·00010	−·00016	−·00022	−·00014	−·00015
21	12	−·00004	−·00013	−·00018	−·00012	−·00010	−·00021	−·00008	−·00002	−·00001	−·00001	−·00006	−·00008	−·00004	+·00009
22	12	−·00003	−·00005	−·00007	−·00002	−·00001	−·00004	+·00001	+·00004	+·00011	+·00006	+·00003	+·00003	+·00005	−·00001
23	12	+·00008	+·00006	+·00012	+·00012	+·00012	+·00007	+·00012	+·00021	+·00024	+·00016	+·00015	+·00018	+·00018	+·00010
Range ...		·00324	·00327	·00367	·00344	·00337	·00318	·00286	·00295	·00260	·00278	·00265	·00263	·00312	·00365

TABLE 52—*continued.*

Bombay Civil Hours.		1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h.	m.													
0	12	+·00016	+·00017	+·00015	+·00024	+·00025	+·00026	+·00030	+·00026	+·00023	+·00025	+·00020	+·00030	+·00024
1	12	+·00022	+·00021	+·00024	+·00026	+·00030	+·00029	+·00031	+·00029	+·00025	+·00032	+·00028	+·00035	+·00029
2	12	+·00019	+·00023	+·00022	+·00026	+·00029	+·00023	+·00025	+·00030	+·00024	+·00028	+·00033	+·00027	+·00035
3	12	+·00009	+·00013	+·00028	+·00019	+·00020	+·00017	+·00016	+·00020	+·00019	+·00023	+·00026	+·00021	+·00024
4	12	+·00003	+·00006	+·00007	+·00007	+·00014	+·00012	+·00005	+·00009	+·00013	+·00016	+·00022	+·00019	+·00016
5	12	+·00019	+·00018	+·00016	+·00016	+·00013	+·00016	−·00001	+·00008	+·00015	+·00022	+·00037	+·00034	+·00026
6	12	+·00085	+·00098	+·00082	+·00065	+·00066	+·00061	+·00033	+·00049	+·00061	+·00083	+·00116	+·00104	+·00106
7	12	+·00156	+·00146	+·00127	+·00109	+·00109	+·00109	+·00083	+·00088	+·00111	+·00130	+·00196	+·00169	+·00171
8	12	+·00192	+·00163	+·00143	+·00132	+·00132	+·00117	+·00105	+·00106	+·00121	+·00142	+·00205	+·00186	+·00188
9	12	+·00148	+·00108	+·00101	+·00088	+·00095	+·00060	+·00075	+·00073	+·00088	+·00093	+·00135	+·00127	+·00123
10	12	+·00028	+·00003	−·00009	+·00029	−·00024	−·00030	−·00003	−·00012	+·00010	−·00016	−·00008	+·00006	+·00008
11	12	−·00116	−·00122	−·00120	−·00103	−·00103	−·00120	−·00072	−·00100	−·00087	−·00124	−·00139	−·00124	−·00123
12	12	−·00184	−·00179	−·00167	−·00168	−·00161	−·00161	−·00126	−·00138	−·00142	−·00189	−·00221	−·00201	−·00182
13	12	−·00165	−·00162	−·00144	−·00142	−·00132	−·00135	−·00113	−·00130	−·00124	−·00150	−·00186	−·00174	−·00164
14	12	−·00115	−·00109	−·00066	−·00087	−·00095	−·00083	−·00067	−·00068	−·00076	−·00083	−·00121	−·00120	−·00104
15	12	−·00054	−·00045	−·00017	−·00035	−·00030	−·00019	−·00025	−·00017	−·00032	−·00017	−·00055	−·00055	−·00050
16	12	·00000	+·00013	+·00024	+·00006	+·00004	+·00016	+·00005	+·00014	−·00003	+·00010	−·00009	−·00006	−·00014
17	12	·00000	+·00009	−·00004	+·00006	+·00007	+·00013	+·00005	+·00015	−·00006	+·00004	−·00004	−·00013	−·00019
18	12	−·00016	−·00001	−·00016	−·00004	−·00008	+·00002	−·00006	+·00003	−·00010	−·00007	−·00021	−·00025	−·00031
19	12	−·00015	−·00015	−·00017	−·00013	−·00012	·00000	−·00009	−·00021	−·00019	−·00015	−·00023	−·00023	−·00027
20	12	−·00017	−·00012	−·00021	−·00013	−·00014	·00000	−·00011	−·00008	−·00019	−·00018	−·00020	−·00021	−·00028
21	12	−·00013	−·00008	−·00009	−·00003	−·00006	+·00005	−·00002	·00000	−·00010	−·00007	−·00017	−·00015	−·00019
22	12	−·00004	−·00003	−·00002	+·00001	+·00005	+·00012	+·00009	+·00009	+·00001	+·00004	−·00004	+·00001	−·00003
23	12	+·00007	+·00011	+·00005	+·00015	+·00015	+·00025	+·00021	+·00020	+·00013	+·00015	+·00009	+·00017	+·00010
Range...		·00376	·00342	·00310	·00300	·00293	·00278	·00231	·00244	·00263	·00331	·00426	·00387	·00370

148. The equivalent east magnetic forces (δ) to the deviations of the declination magnet from its normal position at each hour (h) may be expressed by the series

$$\delta_h = A_1 \cos hz + B_1 \sin hz + A_2 \cos 2\,hz + B_2 \sin 2\,hz + A_3 \cos 3\,hz + B_3 \sin 3\,hz + \&c. \qquad (y)$$

where $z = 15°$, and h represents the hour; and it is easy from each complete set of hourly values to deduce the values of the coefficients A_1, B_1; A_2, B_2; A_3, B_3; &c. This has been done for the mean solar-diurnal variation for each month of each year in the period 1846 to 1872, with results as shown in the following tables.

TABLE 53.—*Showing, for the period* 1846 *to* 1872, *the calculated values of the coefficients* A_1, B_1; A_2, B_2; A_3, B_3; A_4 *and* B_4 *in the series* (y) *which expresses the mean solar diurnal variation for each month and each year.*

MONTH.	JANUARY.								FEBRUARY.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	−·00024	−·00049	+·00023	+·00012	+·00016	+·00009	−·00022	−·00001	−·00008	−·00022	−·00038	+·00009	+·00057	−·00011	−·00036	+·00009
1847	−·00005	−·00019	+·00003	·00000	+·00022	+·00004	−·00023	−·00003	+·00011	−·00012	−·00021	+·00007	+·00037	−·00010	−·00026	+·00009
1848	−·00023	+·00011	+·00013	−·00030	+·00040	+·00018	−·00044	+·00001	−·00008	·00000	+·00012	−·00003	+·00025	+·00013	−·00037	−·00003
1849	−·00024	−·00005	+·00017	−·00052	+·00019	+·00045	−·00033	−·00024	−·00018	+·00018	+·00050	−·00065	+·00020	+·00056	−·00037	−·00018
1850	−·00013	−·00014	+·00017	−·00025	+·00023	+·00029	−·00035	−·00014	−·00017	−·00023	+·00021	−·00037	+·00020	+·00041	−·00027	−·00014
1851	−·00015	+·00007	+·00015	−·00046	+·00030	+·00042	−·00032	−·00009	−·00024	−·00005	+·00014	+·00012	+·00033	·00000	−·00032	+·00008
1852	−·00011	−·00022	+·00037	−·00013	−·00010	+·00032	−·00007	−·00016	−·00019	−·00002	+·00035	−·00027	+·00005	+·00021	−·00021	−·00004
1853	−·00023	−·00021	+·00044	−·00028	−·00015	+·00037	−·00004	−·00015	+·00006	−·00001	+·00005	−·00002	+·00026	+·00012	−·00025	−·00008
1854	−·00026	−·00044	−·00001	−·00005	+·00032	+·00015	−·00030	−·00003	+·00018	−·00019	+·00023	−·00013	+·00008	+·00019	−·00018	−·00009
1855	−·00002	−·00043	+·00023	−·00020	+·00002	+·00023	−·00012	−·00016	−·00019	−·00007	+·00023	−·00031	+·00010	+·00032	−·00018	−·00011
1856	−·00005	−·00019	·00000	−·00024	+·00046	+·00024	−·00042	−·00002	−·00003	−·00007	−·00002	−·00020	+·00019	+·00017	−·00021	−·00006
1857	−·00008	−·00028	+·00025	−·00022	+·00003	+·00031	−·00011	−·00011	−·00020	−·00010	+·00033	−·00034	−·00002	+·00034	−·00010	−·00013
1858	−·00023	−·00014	+·00044	−·00023	·00000	+·00026	−·00024	−·00005	−·00001	−·00008	+·00015	−·00017	+·00018	+·00017	−·00023	−·00002
1859	−·00005	+·00003	−·00002	−·00025	+·00032	+·00022	−·00045	−·00004	·00000	−·00016	+·00011	−·00033	+·00014	+·00026	−·00032	−·00003
1860	−·00023	+·00002	+·00039	−·00037	+·00013	+·00027	−·00029	−·00009	−·00024	+·00016	+·00043	−·00037	+·00001	+·00033	−·00025	·00000
1861	·00000	−·00007	−·00036	−·00029	+·00034	+·00015	−·00015	·00000	−·00003	+·00024	+·00007	−·00041	+·00017	+·00034	−·00029	−·00011
1862	−·00016	−·00018	+·00035	−·00028	+·00003	+·00031	−·00021	−·00016	+·00011	+·00019	−·00019	−·00012	+·00047	+·00004	−·00039	+·00010
1863	+·00013	−·00008	+·00007	−·00026	+·00024	+·00016	−·00030	+·00002	+·00004	+·00001	+·00009	−·00015	+·00012	+·00018	−·00016	−·00004
1864	−·00001	−·00025	+·00024	−·00021	+·00002	+·00030	−·00017	−·00014	−·00001	−·00008	+·00020	−·00024	+·00023	+·00025	−·00016	−·00001
1865	+·00018	−·00067	−·00004	+·00019	+·00030	−·00014	−·00020	+·00014	+·00033	−·00027	−·00016	+·00004	+·00026	·00000	−·00013	·00000
1866	+·00002	−·00022	+·00021	−·00031	+·00005	+·00038	−·00011	−·00017	−·00014	−·00019	+·00019	−·00018	+·00013	+·00026	−·00013	−·00012
1867	+·00021	−·00027	−·00015	−·00026	+·00039	+·00019	−·00032	+·00003	+·00004	−·00021	+·00024	−·00005	+·00004	+·00017	−·00015	−·00005
1868	·00000	−·00029	+·00024	−·00005	+·00002	+·00015	−·00007	−·00012	−·00010	+·00003	+·00024	−·00032	+·00013	+·00035	−·00022	−·00014
1869	−·00003	−·00038	+·00051	+·00008	−·00008	+·00012	−·00022	−·00004	+·00013	−·00013	+·00017	+·00009	+·00013	−·00002	−·00020	+·00007
1870	+·00011	+·00005	−·00008	−·00005	+·00031	+·00005	−·00033	+·00004	−·00021	+·00033	−·00017	−·00035	+·00051	+·00011	−·00041	+·00014
1871	−·00008	−·00008	+·00022	−·00015	+·00022	+·00022	−·00038	−·00010	−·00011	+·00019	+·00043	−·00029	+·00006	+·00021	−·00031	−·00004
1872	−·00014	·00000	+·00041	−·00033	·00000	+·00041	−·00014	−·00024	−·00022	+·00039	+·00046	−·00042	+·00007	+·00030	−·00032	+·00003
Mean ...	−·00008	−·00018	+·00017	−·00020	+·00016	+·00023	−·00024	−·00008	−·00005	−·00002	+·00014	−·00019	+·00019	+·00019	−·00025	−·00003

TABLE 53—*continued.*

MONTH.	MARCH.								APRIL.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	+ ·00013	+ ·00020	− ·00035	− ·00035	+ ·00060	+ ·00022	− ·00029	− ·00008	+ ·00034	+ ·00073	− ·00064	− ·00061	+ ·00084	+ ·00031	− ·00033	+ ·00001
1847	+ ·00010	+ ·00042	− ·00025	− ·00055	+ ·00048	+ ·00037	− ·00026	− ·00012	+ ·00055	+ ·00069	− ·00081	− ·00022	+ ·00079	− ·00013	− ·00019	+ ·00016
1848	− ·00005	+ ·00060	− ·00043	− ·00058	+ ·00082	+ ·00023	− ·00016	+ ·00005	+ ·00050	+ ·00076	− ·00056	− ·00050	+ ·00096	+ ·00010	− ·00024	+ ·00016
1849	− ·00017	+ ·00057	+ ·00002	− ·00075	+ ·00061	+ ·00044	− ·00041	− ·00006	+ ·00030	+ ·00094	− ·00065	− ·00078	+ ·00087	+ ·00023	− ·00028	+ ·00017
1850	− ·00022	+ ·00044	+ ·00019	− ·00064	+ ·00040	+ ·00045	− ·00037	− ·00015	+ ·00042	+ ·00078	− ·00061	− ·00039	+ ·00090	+ ·00025	− ·00026	− ·00005
1851	− ·00003	+ ·00036	− ·00019	− ·00026	+ ·00057	+ ·00020	− ·00037	− ·00008	+ ·00026	+ ·00071	− ·00045	− ·00055	+ ·00083	+ ·00025	− ·00032	+ ·00001
1852	− ·00016	+ ·00048	− ·00007	− ·00051	+ ·00058	+ ·00022	− ·00037	·00000	+ ·00055	+ ·00080	− ·00090	− ·00048	+ ·00098	+ ·00010	− ·00031	+ ·00014
1853	+ ·00001	+ ·00005	− ·00008	− ·00026	+ ·00048	+ ·00017	− ·00041	− ·00007	+ ·00062	+ ·00091	− ·00072	− ·00046	+ ·00083	+ ·00015	− ·00030	+ ·00015
1854	+ ·00008	+ ·00029	− ·00002	− ·00033	+ ·00034	+ ·00035	− ·00019	− ·00011	+ ·00055	+ ·00069	− ·00059	− ·00043	+ ·00075	+ ·00012	− ·00027	+ ·00007
1855	+ ·00023	+ ·00023	− ·00029	− ·00027	+ ·00050	+ ·00017	− ·00030	− ·00002	+ ·00057	+ ·00077	− ·00066	− ·00045	+ ·00074	+ ·00022	− ·00025	+ ·00002
1856	− ·00001	+ ·00030	− ·00017	− ·00027	+ ·00043	+ ·00017	− ·00029	− ·00001	+ ·00018	+ ·00080	− ·00055	− ·00045	+ ·00071	+ ·00030	− ·00025	+ ·00005
1857	− 00007	+ ·00015	− ·00012	− ·00019	+ ·00041	+ ·00003	− ·00022	·00000	+ ·00035	+ ·00066	− ·00047	− ·00026	+ ·00061	+ ·00012	− ·00014	+ ·00003
1858	− ·00006	+ ·00051	− ·00007	− ·00065	+ ·00053	+ ·00038	− ·00034	− ·00012	+ ·00056	+ ·00078	− ·00085	− ·00052	+ ·00087	+ ·00023	− ·00024	+ ·00002
1859	− 00001	+ ·00063	− ·00011	− ·00065	+ ·00057	+ ·00029	− ·00047	− ·00004	+ ·00078	+ ·00094	− ·00088	− ·00085	+ ·00100	+ ·00033	− ·00045	+ ·00009
1860	− ·00012	+ ·00051	·00000	− ·00066	+ ·00065	+ ·00041	− ·00039	− ·00011	+ ·00053	+ ·00075	− ·00091	− ·00043	+ ·00096	·00000	− ·00027	+ ·00021
1861	+ ·00005	+ ·00052	− ·00036	− ·00053	+ ·00067	+ ·00027	− ·00043	− ·00001	+ ·00019	+ ·00097	− ·00053	− ·00074	+ ·00085	+ ·00033	− ·00030	+ ·00004
1862	+ ·00003	+ ·00044	− ·00020	− ·00018	+ ·00056	+ ·00007	− ·00054	+ ·00003	+ ·00066	+ ·00077	− ·00081	− ·00040	+ ·00088	+ ·00002	− ·00036	+ ·00019
1863	− ·00003	+ ·00035	− ·00020	− ·00030	+ ·00053	+ ·00023	− ·00040	− ·00003	+ ·00047	+ ·00078	− ·00070	− ·00044	+ ·00077	+ ·00018	− ·00023	− ·00003
1864	+ ·00018	+ ·00049	− ·00030	− ·00044	+ ·00058	+ ·00018	− ·00031	+ ·00002	+ ·00051	+ ·00081	− ·00055	− ·00056	+ ·00077	+ ·00023	− ·00023	+ ·00009
1865	+ ·00030	+ ·00038	− ·00023	− ·00036	+ ·00047	+ ·00022	− ·00024	− ·00008	+ ·00060	+ ·00071	− ·00065	− ·00032	+ ·00077	+ ·00006	− ·00024	+ ·00007
1866	+ ·00015	+ ·00029	− ·00030	− ·00018	+ ·00054	− ·00002	− ·00032	+ ·00012	+ ·00032	+ ·00083	− ·00042	− ·00056	+ ·00068	+ ·00028	− ·00036	+ ·00001
1867	+ ·00014	+ ·00023	− ·00011	− ·00034	+ ·00041	+ ·00028	− ·00025	− ·00014	+ ·00041	+ ·00069	− ·00068	− ·00047	+ ·00077	+ ·00015	− ·00026	+ ·00007
1868	− ·00008	+ ·00035	− ·00005	− ·00047	+ ·00038	+ ·00033	− ·00031	− ·00012	+ ·00056	+ ·00071	− ·00083	− ·00040	+ ·00083	+ ·00006	− ·00034	+ ·00010
1869	+ ·00015	+ ·00045	− ·00019	− ·00012	+ ·00063	+ ·00023	− ·00027	− ·00021	+ ·00051	+ ·00064	− ·00082	− ·00031	+ ·00093	+ ·00005	− ·00043	+ ·00008
1870	+ ·00026	+ ·00064	− ·00039	− ·00031	+ ·00058	+ ·00005	− ·00024	+ ·00003	+ ·00050	+ ·00108	− ·00077	− ·00080	+ ·00096	+ ·00022	− ·00039	+ ·00017
1871	− ·00006	+ ·00086	− ·00018	− ·00069	+ ·00065	+ ·00026	− ·00046	+ ·00007	+ ·00088	+ ·00112	− ·00092	− ·00064	+ ·00101	+ ·00016	− ·00025	+ ·00008
1872	+ ·00024	+ ·00062	− ·00049	− ·00042	+ ·00089	+ ·00005	− ·00043	+ ·00016	+ ·00050	+ ·00114	− ·00078	− ·00058	+ ·00088	+ ·00007	− ·00021	+ ·00015
Mean ...	+ ·00004	+ ·00042	− ·00018	− ·00042	+ ·00055	+ ·00023	− ·00033	− ·00004	+ ·00049	+ ·00081	− ·00069	− ·00050	+ ·00084	+ ·00016	− ·00029	+ ·00008

TABLE 53—*continued.*

Month.	May.								June.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	+ ·00066	+ ·00089	− ·00102	− ·00047	+ ·00087	+ ·00007	− ·00012	+ ·00017	+ ·00063	+ ·00109	− ·00092	− ·00052	+ ·00078	+ ·00010	− ·00008	+ ·00009
1847	+ ·00059	+ ·00067	− ·00100	− ·00026	+ ·00072	− ·00009	− ·00006	+ ·00015	+ ·00048	+ ·00100	− ·00104	− ·00040	+ ·00085	·00000	− ·00010	+ ·00005
1848	+ ·00065	+ ·00102	− ·00098	− ·00042	+ ·00099	− ·00008	− ·00011	+ ·00023	+ ·00047	+ ·00107	− ·00098	− ·00059	+ ·00086	+ ·00007	− ·00014	+ ·00022
1849	+ ·00062	+ ·00098	− ·00111	− ·00040	+ ·00106	− ·00010	− ·00022	+ ·00016	+ ·00057	+ ·00117	− ·00106	− ·00058	+ ·00095	+ ·00007	− ·00013	+ ·00007
1850	+ ·00078	+ ·00091	− ·00103	− ·00037	+ ·00099	− ·00005	− ·00012	+ ·00016	+ ·00069	+ ·00119	− ·00105	− ·00048	+ ·00091	− ·00002	− ·00008	+ ·00017
1851	+ ·00054	+ ·00082	− ·00084	− ·00051	+ ·00082	+ ·00015	− ·00015	+ ·00010	+ ·00045	+ ·00105	− ·00099	− ·00049	+ ·00081	+ ·00004	− ·00004	+ ·00015
1852	+ ·00060	+ ·00111	− ·00095	− ·00027	+ ·00084	− ·00005	− ·00019	+ ·00020	+ ·00058	+ ·00121	− ·00100	− ·00057	+ ·00050	+ ·00008	− ·00009	+ ·00014
1853	+ ·00076	+ ·00071	− ·00108	− ·00036	+ ·00078	− ·00009	− ·00015	+ ·00020	+ ·00094	+ ·00122	− ·00116	− ·00035	+ ·00076	+ ·00001	·00000	+ ·00009
1854	+ ·00073	+ ·00097	− ·00094	− ·00035	+ ·00080	− ·00004	− ·00008	+ ·00017	+ ·00054	+ ·00110	− ·00078	− ·00041	+ ·00078	·00000	− ·00012	+ ·00013
1855	+ ·00062	+ ·00099	− ·00088	− ·00034	+ ·00077	− ·00002	− ·00014	+ ·00019	+ ·00039	+ ·00110	− ·00071	− ·00045	+ ·00069	+ ·00016	− ·00016	+ ·00002
1856	+ ·00047	+ ·00081	− ·00064	− ·00017	+ ·00062	− ·00003	− ·00013	+ ·00009	+ ·00053	+ ·00111	− ·00069	− ·00026	+ ·00065	+ ·00002	− ·00012	+ ·00013
1857	+ ·00071	+ ·00101	− ·00087	− ·00036	+ ·00083	+ ·00002	− ·00025	+ ·00014	+ ·00048	+ ·00099	− ·00072	− ·00027	+ ·00066	− ·00003	− ·00008	+ ·00008
1858	+ ·00057	+ ·00107	− ·00108	− ·00054	+ ·00089	+ ·00003	− ·00018	+ ·00020	+ ·00062	+ ·00111	− ·00087	− ·00055	+ ·00067	+ ·00009	·00000	+ ·00013
1859	+ ·00067	+ ·00099	− ·00144	− ·00054	+ ·00109	− ·00009	− ·00005	+ ·00026	+ ·00052	+ ·00130	− ·00114	− ·00070	+ ·00089	+ ·00014	− ·00008	+ ·00009
1860	+ ·00057	+ ·00093	− ·00123	− ·00055	+ ·00101	− ·00011	− ·00014	+ ·00024	+ ·00078	+ ·00120	− ·00133	− ·00072	+ ·00100	+ ·00015	− ·00013	+ ·00023
1861	+ ·00063	+ ·00091	− ·00105	− ·00037	+ ·00089	+ ·00002	− ·00013	+ ·00017	+ ·00080	+ ·00120	− ·00112	− ·00042	+ ·00084	− ·00001	+ ·00004	+ ·00017
1862	+ ·00057	+ ·00075	− ·00100	− ·00010	+ ·00085	− ·00011	− ·00023	+ ·00012	+ ·00065	+ ·00106	− ·00124	− ·00040	+ ·00087	+ ·00004	− ·00002	+ ·00012
1863	+ ·00074	+ ·00105	− ·00112	− ·00043	+ ·00095	− ·00002	− ·00018	+ ·00020	+ ·00069	+ ·00100	− ·00097	− ·00038	+ ·00077	+ ·00007	− ·00007	+ ·00007
1864	+ ·00047	+ ·00100	− ·00078	− ·00045	+ ·00069	+ ·00007	− ·00010	+ ·00019	+ ·00065	+ ·00142	− ·00099	− ·00052	+ ·00083	+ ·00006	− ·00016	+ ·00015
1865	+ ·00056	+ ·00095	− ·00100	− ·00026	+ ·00083	− ·00013	− ·00007	+ ·00019	+ ·00062	+ ·00115	− ·00084	− ·00049	+ ·00065	+ ·00012	− ·00007	+ ·00010
1866	+ ·00053	+ ·00094	− ·00059	− ·00027	+ ·00060	− ·00001	− ·00011	+ ·00013	+ ·00058	+ ·00113	− ·00061	− ·00042	+ ·00058	+ ·00011	− ·00010	+ ·00007
1867	+ ·00055	+ ·00086	− ·00082	− ·00017	+ ·00071	− ·00012	− ·00015	+ ·00014	+ ·00044	+ ·00124	− ·00055	− ·00037	+ ·00073	+ ·00005	− ·00019	− ·00004
1868	+ ·00056	+ ·00089	− ·00083	− ·00028	+ ·00072	− ·00001	− ·00008	+ ·00013	+ ·00053	+ ·00128	− ·00084	− ·00050	+ ·00076	+ ·00007	− ·00015	+ ·00015
1869	+ ·00065	+ ·00065	− ·00109	− ·00014	+ ·00092	− ·00022	− ·00016	+ ·00016	+ ·00072	+ ·00125	− ·00136	− ·00042	+ ·00101	− ·00001	− ·00007	+ ·00021
1870	+ ·00029	+ ·00107	− ·00111	− ·00057	+ ·00085	+ ·00006	+ ·00002	+ ·00025	+ ·00087	+ ·00134	− ·00142	− ·00057	+ ·00091	+ ·00001	− ·00009	+ ·00014
1871	+ ·00060	+ ·00107	− ·00121	− ·00036	+ ·00095	− ·00013	− ·00004	+ ·00017	+ ·00076	+ ·00123	− ·00136	− ·00060	+ ·00099	+ ·00011	− ·00003	+ ·00010
1872	+ ·00091	+ ·00122	− ·00137	− ·00035	+ ·00104	− ·00003	− ·00012	+ ·00020	+ ·00069	+ ·00108	− ·00114	− ·00033	+ ·00072	− ·00011	+ ·00010	+ ·00021
Mean ...	+ ·00061	+ ·00093	− ·00100	− ·00036	+ ·00085	− ·00004	− ·00013	+ ·00017	+ ·00062	+ ·00116	− ·00100	− ·00047	+ ·00079	+ ·00005	− ·00008	+ ·00012

TABLE 53—*continued.*

MONTH.	JULY.								AUGUST.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	+·00062	+·00101	−·00104	−·00039	+·00073	+·00001	−·00004	+·00012	+·00088	+·00093	−·00143	−·00047	+·00098	−·00007	−·00009	+·00018
1847	+·00068	+·00089	−·00120	−·00026	+·00082	−·00006	·00000	+·00006	+·00058	+·00101	−·00109	−·00037	+·00089	−·00004	−·00007	+·00013
1848	+·00073	+·00122	−·00133	−·00065	+·00094	+·00012	−·00009	+·00021	+·00080	+·00105	−·00144	−·00030	+·00105	−·00020	−·00005	+·00024
1849	+·00063	+·00112	−·00118	−·00044	+·00083	−·00002	−·00003	+·00008	+·00067	+·00103	−·00136	−·00021	+·00096	−·00014	−·00015	+·00017
1850	+·00069	+·00119	−·00114	−·00055	+·00092	+·00009	−·00014	+·00014	+·00056	+·00107	−·00111	−·00048	+·00081	+·00006	−·00008	+·00015
1851	+·00057	+·00117	−·00093	−·00043	+·00081	+·00013	−·00011	+·00008	+·00061	+·00087	−·00098	−·00018	+·00074	−·00009	−·00004	+·00014
1852	+·00081	+·00109	−·00103	−·00029	+·00077	−·00001	−·00007	+·00015	+·00077	+·00091	−·00132	−·00028	+·00093	−·00011	−·00006	+·00010
1853	+·00079	+·00108	−·00120	−·00014	+·00084	−·00020	+·00002	+·00018	+·00092	+·00099	−·00153	−·00032	+·00107	−·00012	−·00013	+·00013
1854	+·00051	+·00112	−·00075	−·00035	+·00067	−·00001	−·00006	+·00011	+·00071	+·00086	−·00102	−·00009	+·00078	−·00013	−·00007	+·00015
1855	+·00047	+·00110	−·00069	−·00037	+·00054	+·00013	−·00004	+·00007	+·00067	+·00086	−·00083	−·00032	+·00067	·00000	−·00010	+·00014
1856	+·00058	+·00099	−·00077	−·00020	+·00057	+·00001	−·00005	+·00006	+·00072	+·00078	−·00112	−·00005	+·00082	−·00021	−·00007	+·00016
1857	+·00055	+·00109	−·00065	−·00023	+·00063	−·00015	−·00011	+·00017	+·00061	+·00086	−·00105	−·00024	+·00082	−·00006	−·00010	+·00015
1858	+·00072	+·00113	−·00098	−·00044	+·00069	−·00004	−·00001	+·00021	+·00097	+·00089	−·00146	−·00016	+·00097	−·00021	−·00012	+·00020
1859	+·00026	+·00129	−·00101	−·00056	+·00077	+·00005	·00000	+·00006	+·00075	+·00102	−·00129	−·00053	+·00103	+·00009	−·00010	+·00017
1860	+·00046	+·00130	−·00113	−·00082	+·00077	+·00031	+·00002	+·00006	+·00090	+·00137	−·00179	−·00061	+·00127	−·00009	−·00017	+·00028
1861	+·00064	+·00115	−·00117	−·00037	+·00082	−·00002	+·00001	+·00011	+·00085	+·00083	−·00168	−·00040	+·00112	−·00016	−·00009	+·00023
1862	+·00044	+·00109	−·00091	−·00032	+·00081	−·00002	−·00002	+·00014	+·00063	+·00097	−·00113	−·00032	+·00088	−·00016	−·00011	+·00024
1863	+·00056	+·00112	−·00112	−·00030	+·00081	−·00006	−·00002	+·00011	+·00077	+·00092	−·00111	−·00040	+·00077	+·00008	−·00009	+·00012
1864	+·00059	+·00105	−·00090	−·00045	+·00069	+·00017	−·00009	+·00005	+·00067	+·00081	−·00133	−·00018	+·00096	−·00016	−·00013	+·00012
1865	+·00050	+·00100	−·00075	−·00034	+·00061	+·00002	−·00007	+·00012	+·00069	+·00083	−·00100	−·00037	+·00072	−·00003	−·00002	+·00013
1866	+·00027	+·00086	−·00060	−·00029	+·00060	+·00015	−·00010	+·00009	+·00063	+·00071	−·00081	−·00019	+·00067	+·00006	−·00009	+·00012
1867	+·00052	+·00109	−·00085	−·00033	+·00070	+·00003	−·00011	+·00012	+·00062	+·00083	−·00091	−·00029	+·00064	+·00003	−·00005	+·00017
1868	+·00043	+·00105	−·00066	−·00035	+·00054	+·00005	−·00006	+·00007	+·00063	+·00084	−·00120	−·00025	+·00087	−·00009	−·00004	+·00015
1869	+·00062	+·00140	−·00123	−·00049	+·00084	+·00005	+·00004	+·00011	+·00060	+·00109	−·00125	−·00068	+·00090	·00000	−·00015	+·00019
1870	+·00085	+·00102	−·00159	−·00033	+·00092	−·00000	+·00008	+·00008	+·00092	+·00114	−·00179	−·00038	+·00124	−·00010	−·00010	+·00020
1871	+·00068	+·00125	−·00143	−·00044	+·00094	−·00014	−·00001	+·00027	+·00081	+·00135	−·00162	−·00054	+·00116	−·00007	−·00004	+·00020
1872	+·00064	+·00118	−·00117	−·00031	+·00080	·00000	+·00001	+·00017	+·00061	+·00120	−·00137	−·00044	+·00098	−·00005	−·00005	+·00023
Mean ...	+·00059	+·00111	−·00102	−·00039	+·00075	+·00002	−·00004	+·00012	+·00072	+·00096	−·00126	−·00034	+·00091	−·00007	−·00009	+·00017

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TABLE 53—*continued.*

Month.	September.								October.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	+ ·00048	+ ·00062	− ·00132	− ·00007	+ ·00108	− ·00026	− ·00023	+ ·00030	+ ·00014	+ ·00023	− ·00045	− ·00016	+ ·00069	− ·00015	− ·00037	+ ·00023
1847	+ ·00047	+ ·00083	− ·00118	− ·00037	+ ·00109	− ·00004	− ·00027	+ ·00016	+ ·00005	+ ·00069	− ·00033	− ·00038	+ ·00078	+ ·00006	− ·00040	+ ·00033
1848	+ ·00066	+ ·00094	− ·00123	− ·00046	+ ·00123	− ·00003	− ·00042	+ ·00025	+ ·00033	+ ·00045	− ·00033	− ·00025	+ ·00062	− ·00006	− ·00033	+ ·00021
1849	+ ·00076	+ ·00090	− ·00115	− ·00040	+ ·00106	− ·00008	− ·00032	+ ·00012	+ ·00028	+ ·00028	− ·00029	− ·00018	+ ·00054	− ·00013	− ·00030	+ ·00024
1850	+ ·00079	+ ·00087	− ·00114	− ·00049	+ ·00111	+ ·00001	− ·00034	+ ·00012	+ ·00017	+ ·00037	− ·00031	− ·00039	+ ·00068	+ ·00001	− ·00031	+ ·00019
1851	+ ·00066	+ ·00067	− ·00102	− ·00033	+ ·00098	− ·00003	− ·00027	+ ·00012	+ ·00043	+ ·00030	− ·00038	− ·00013	+ ·00068	− ·00008	− ·00037	+ ·00016
1852	+ ·00059	+ ·00056	− ·00083	− ·00030	+ ·00078	− ·00012	− ·00018	+ ·00022	+ ·00030	+ ·00013	− ·00030	− ·00013	+ ·00054	− ·00010	− ·00027	+ ·00017
1853	+ ·00069	+ ·00079	− ·00128	− ·00023	+ ·00103	− ·00031	− ·00019	+ ·00025	+ ·00022	+ ·00010	− ·00019	+ ·00001	+ ·00046	− ·00016	− ·00018	+ ·00020
1854	+ ·00085	+ ·00049	− ·00104	+ ·00004	+ ·00090	− ·00017	− ·00027	+ ·00013	+ ·00037	+ ·00010	− ·00034	− ·00001	+ ·00052	− ·00011	− ·00027	+ ·00007
1855	+ ·00075	+ ·00057	− ·00118	− ·00016	+ ·00099	− ·00017	− ·00032	+ ·00017	+ ·00041	+ ·00017	− ·00033	− ·00011	+ ·00050	− ·00002	− ·00028	+ ·00009
1856	+ ·00085	+ ·00063	− ·00104	− ·00025	+ ·00095	− ·00009	− ·00035	+ ·00012	+ ·00041	+ ·00004	− ·00032	− ·00005	+ ·00047	− ·00006	− ·00026	+ ·00011
1857	+ ·00064	+ ·00098	− ·00128	− ·00034	+ ·00125	− ·00024	− ·00042	+ ·00029	+ ·00029	+ ·00031	− ·00035	− ·00033	+ ·00066	+ ·00012	− ·00031	+ ·00004
1858	+ ·00080	+ ·00088	− ·00117	− ·00042	+ ·00105	+ ·00003	− ·00033	+ ·00011	+ ·00019	+ ·00043	− ·00011	− ·00050	+ ·00052	+ ·00023	− ·00035	+ ·00010
1859	+ ·00078	+ ·00107	− ·00120	− ·00058	+ ·00112	− ·00004	− ·00043	+ ·00025	+ ·00002	+ ·00060	− ·00039	− ·00039	+ ·00076	− ·00001	− ·00042	+ ·00019
1860	+ ·00077	+ ·00085	− ·00136	− ·00032	+ ·00113	− ·00012	− ·00028	+ ·00017	+ ·00041	+ ·00050	− ·00052	− ·00032	+ ·00067	+ ·00011	− ·00048	+ ·00015
1861	+ ·00086	+ ·00072	− ·00144	− ·00010	+ ·00117	− ·00033	− ·00032	+ ·00029	+ ·00028	+ ·00014	− ·00044	− ·00005	+ ·00059	− ·00009	− ·00023	+ ·00019
1862	+ ·00049	+ ·00078	− ·00112	− ·00044	+ ·00102	− ·00005	− ·00027	+ ·00012	+ ·00010	+ ·00016	− ·00032	− ·00008	+ ·00054	− ·00017	− ·00035	+ ·00026
1863	+ ·00064	+ ·00066	− ·00090	− ·00032	+ ·00083	+ ·00002	− ·00026	+ ·00011	+ ·00016	+ ·00019	− ·00028	− ·00022	+ ·00086	+ ·00001	− ·00038	+ ·00020
1864	+ ·00071	+ ·00051	− ·00123	− ·00014	+ ·00101	− ·00017	− ·00032	+ ·00016	+ ·00032	+ ·00004	− ·00029	− ·00005	+ ·00050	− ·00004	− ·00026	+ ·00009
1865	+ ·00067	+ ·00048	− ·00098	− ·00025	+ ·00083	− ·00003	− ·00033	+ ·00014	+ ·00026	+ ·00003	− ·00035	− ·00011	+ ·00052	− ·00010	− ·00029	+ ·00013
1866	+ ·00058	+ ·00046	− ·00085	− ·00010	+ ·00080	− ·00017	− ·00023	+ ·00019	+ ·00038	− ·00006	− ·00051	− ·00023	+ ·00068	+ ·00001	− ·00035	+ ·00013
1867	+ ·00067	+ ·00035	− ·00083	− ·00017	+ ·00077	+ ·00005	− ·00024	+ ·00009	+ ·00030	− ·00011	− ·00045	+ ·00007	+ ·00059	− ·00008	− ·00032	+ ·00009
1868	+ ·00064	+ ·00066	− ·00105	− ·00020	+ ·00087	− ·00012	− ·00023	+ ·00018	+ ·00018	+ ·00034	− ·00006	− ·00008	+ ·00050	− ·00012	− ·00023	+ ·00022
1869	+ ·00083	+ ·00093	− ·00109	− ·00065	+ ·00106	+ ·00012	− ·00035	+ ·00008	+ ·00045	+ ·00011	− ·00039	− ·00005	+ ·00058	− ·00007	− ·00032	+ ·00016
1870	+ ·00078	+ ·00113	− ·00155	− ·00050	+ ·00134	− ·00009	− ·00039	+ ·00033	+ ·00034	+ ·00075	− ·00050	− ·00047	+ ·00080	·00000	− ·00050	+ ·00024
1871	+ ·00085	+ ·00093	− ·00130	− ·00051	+ ·00113	+ ·00004	− ·00031	+ ·00020	+ ·00046	+ ·00039	− ·00053	− ·00013	+ ·00076	− ·00025	− ·00035	+ ·00030
1872	+ ·00088	+ ·00114	− ·00125	− ·00064	+ ·00109	− ·00004	− ·00035	+ ·00035	+ ·00046	+ ·00062	− ·00058	− ·00034	+ ·00078	− ·00002	− ·00042	+ ·00016
Mean ...	+ ·00071	+ ·00076	− ·00115	− ·00032	+ ·00102	− ·00009	− ·00030	+ ·00019	+ ·00029	+ ·00027	− ·00036	− ·00019	+ ·00062	− ·00005	− ·00033	+ ·00017

TABLE 53—*continued.*

Month.	November.								December.							
Coefficient.	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
Year.																
1846	+ ·00005	− ·00032	·00000	+ ·00004	+ ·00034	− ·00001	− ·00029	+ ·00009	− ·00019	− ·00037	+ ·00024	− ·00009	+ ·00012	+ ·00023	− ·00020	− ·00008
1847	+ ·00002	− ·00004	+ ·00020	− ·00001	+ ·00017	+ ·00005	− ·00025	+ ·00016	+ ·00006	− ·00021	+ ·00031	+ ·00002	− ·00015	+ ·00006	− ·00010	− ·00002
1848	− ·00007	− ·00023	+ ·00026	− ·00009	+ ·00016	+ ·00011	− ·00006	+ ·00015	− ·00012	− ·00035	+ ·00036	− ·00006	− ·00002	+ ·00017	− ·00017	− ·00004
1849	+ ·00007	− ·00020	+ ·00019	+ ·00005	+ ·00014	·00000	− ·00010	+ ·00015	− ·00014	− ·00025	+ ·00026	+ ·00009	+ ·00013	+ ·00002	− ·00018	− ·00001
1850	+ ·00008	− ·00023	+ ·00009	+ ·00013	+ ·00023	− ·00006	− ·00022	+ ·00011	+ ·00002	− ·00026	− ·00021	+ ·00001	+ ·00033	− ·00006	− ·00027	+ ·00010
1851	+ ·00019	− ·00004	− ·00012	+ ·00009	+ ·00030	− ·00009	− ·00027	+ ·00022	+ ·00003	− ·00028	− ·00008	+ ·00007	+ ·00023	+ ·00007	− ·00020	+ ·00015
1852	− ·00020	− ·00006	+ ·00025	− ·00030	+ ·00010	+ ·00028	− ·00020	− ·00002	+ ·00004	− ·00070	+ ·00030	+ ·00015	+ ·00002	+ ·00011	− ·00006	− ·00005
1853	+ ·00019	− ·00036	+ ·00011	+ ·00013	+ ·00021	+ ·00002	− ·00016	+ ·00009	+ ·00022	− ·00057	+ ·00004	+ ·00013	+ ·00002	+ ·00007	− ·00010	·00000
1854	+ ·00003	− ·00035	+ ·00031	+ ·00002	+ ·00006	+ ·00013	− ·00008	+ ·00004	+ ·00008	− ·00049	+ ·00005	+ ·00008	+ ·00013	+ ·00004	− ·00013	+ ·00002
1855	+ ·00035	− ·00037	− ·00009	+ ·00008	+ ·00024	+ ·00002	− ·00021	+ ·00016	+ ·00004	− ·00035	− ·00011	+ ·00007	+ ·00031	− ·00013	− ·00022	+ ·00023
1856	+ ·00002	− ·00030	+ ·00032	+ ·00015	− ·00001	− ·00002	− ·00008	+ ·00014	+ ·00001	− ·00052	+ ·00019	+ ·00007	+ ·00009	·00000	− ·00017	+ ·00005
1857	+ ·00015	− ·00026	+ ·00018	+ ·00005	+ ·00012	− ·00009	− ·00012	+ ·00010	− ·00027	− ·00018	+ ·00033	− ·00023	·00000	+ ·00014	− ·00013	− ·00004
1858	+ ·00003	− ·00021	+ ·00030	− ·00008	+ ·00012	+ ·00007	− ·00017	+ ·00008	− ·00003	− ·00015	+ ·00023	− ·00024	+ ·00016	+ ·00018	− ·00028	·00000
1859	− ·00003	·00000	+ ·00035	− ·00018	+ ·00009	+ ·00006	− ·00023	+ ·00009	− ·00006	− ·00031	+ ·00074	− ·00001	− ·00030	+ ·00010	+ ·00001	− ·00002
1860	− ·00001	− ·00016	+ ·00022	+ ·00006	+ ·00011	+ ·00007	− ·00023	+ ·00001	− ·00008	− ·00013	+ ·00001	·00000	+ ·00020	+ ·00003	− ·00028	+ ·00007
1861	+ ·00007	− ·00029	+ ·00028	+ ·00003	+ ·00011	+ ·00006	− ·00021	+ ·00007	+ ·00002	− ·00030	+ ·00037	− ·00012	+ ·00003	+ ·00020	− ·00011	− ·00011
1862	·00000	− ·00023	+ ·00029	− ·00003	+ ·00005	+ ·00004	− ·00015	+ ·00009	+ ·00026	− ·00034	− ·00004	+ ·00027	+ ·00008	+ ·00007	− ·00036	+ ·00004
1863	+ ·00014	− ·00048	+ ·00032	+ ·00012	·00000	− ·00007	− ·00012	+ ·00010	+ ·00010	− ·00058	+ ·00018	+ ·00009	·00000	+ ·00014	− ·00012	− ·00002
1864	+ ·00014	− ·00030	+ ·00021	+ ·00009	+ ·00009	+ ·00006	− ·00013	+ ·00010	+ ·00019	− ·00039	+ ·00012	+ ·00024	+ ·00001	− ·00004	− ·00023	− ·00003
1865	+ ·00030	− ·00049	− ·00010	+ ·00003	+ ·00013	− ·00006	− ·00016	+ ·00009	+ ·00010	− ·00043	+ ·00007	− ·00003	+ ·00009	+ ·00012	− ·00022	− ·00001
1866	+ ·00008	− ·00056	+ ·00023	+ ·00012	+ ·00007	− ·00006	− ·00004	+ ·00009	+ ·00005	− ·00069	+ ·00026	+ ·00016	− ·00001	− ·00003	− ·00003	+ ·00005
1867	+ ·00015	− ·00050	+ ·00016	+ ·00018	+ ·00001	− ·00006	− ·00013	+ ·00005	+ ·00014	− ·00054	+ ·00015	+ ·00023	+ ·00001	− ·00005	− ·00003	+ ·00001
1868	+ ·00012	− ·00028	+ ·00011	+ ·00004	+ ·00013	+ ·00002	− ·00015	+ ·00005	+ ·00012	− ·00028	+ ·00011	+ ·00004	+ ·00013	+ ·00003	− ·00015	+ ·00005
1869	+ ·00012	− ·00031	+ ·00025	+ ·00011	+ ·00007	− ·00002	− ·00018	+ ·00009	+ ·00011	− ·00020	− ·00008	+ ·00020	+ ·00030	− ·00014	− ·00033	+ ·00024
1870	·00000	+ ·00031	+ ·00035	− ·00018	+ ·00014	+ ·00011	− ·00023	+ ·00016	− ·00002	− ·00011	+ ·00033	− ·00001	+ ·00011	+ ·00001	− ·00024	+ ·00007
1871	+ ·00024	+ ·00003	+ ·00018	− ·00016	+ ·00021	+ ·00013	− ·00025	+ ·00006	+ ·00015	− ·00035	+ ·00031	+ ·00009	+ ·00003	+ ·00001	− ·00017	− ·00005
1872	− ·00005	− ·00009	+ ·00031	− ·00003	+ ·00028	+ ·00003	− ·00031	+ ·00013	− ·00002	− ·00020	+ ·00009	+ ·00010	+ ·00027	− ·00008	− ·00032	+ ·00015
Mean ...	+ ·00008	− ·00023	+ ·00019	+ ·00002	+ ·00014	+ ·00003	− ·00018	+ ·00010	+ ·00003	− ·00035	+ ·00017	+ ·00005	+ ·00009	+ ·00005	− ·00018	+ ·00003
And the means for the twenty-seven years and for the twelve months are									+ ·00034	+ ·00047	− ·00050	− ·00028	+ ·00058	+ ·00006	− ·00020	+ ·00008

149. As the hourly excesses from which these coefficients were calculated included the effect of progressive change from day to day—whether arising from annual variation or secular increase of magnetic declination—they require correction for that part of them which is due to such progressive change: whether the correction is of sufficient magnitude to demand its application we will now inquire. For the years 1866 to 1872, whose hourly excesses were arranged in the order of observation, the first being for $0^h\ 12^m$ of Bombay civil time, the B coefficients only will require correction; but for the years 1846 to 1865, whose hourly excesses were re-arranged so as to place the 9th hour of observation (8^h of Göttingen astronomical time) in the position of the hour 0 of Bombay civil time, the first hour of observation in the position of the hour 16, and so on, corrections will be required both for the A and B coefficients.

The general expression for the value of the B coefficient of the tth order is*

$$B_t = \frac{2}{N}\left\{ a_1 \sin t z + a_2 \sin 2 t z + \ldots\ldots\ldots + a_{N-1} \sin (N-1)\, t\, z \right\}$$

where N is the number of observations *per* day and a_1, a_2, ... $a_{(N-1)}$ are the excesses of the hours 1, 2 &c. ... (N−1), or these excesses *plus* or *minus* any constant. If c represent the increment of declination *per* day we may substitute for a_1, a_2 ..... $a_{(N-1)}$—regarded as due to the progressive increase—

$$\frac{c}{N}\ \frac{2c}{N}\ \ldots\ldots\ldots\ \frac{(N-1)c}{N},\ \text{when the expression becomes}$$

$$B_t = \frac{2c}{N^2}\left\{ \sin t z + 2 \sin t z + \ldots\ldots\ldots + (N-1) \sin (N-1)\, t z \right\}$$

When $N z = 2\pi$, as in the present case, the factor within brackets is equal to $-\frac{N}{2} \cot \frac{t z}{2}$, whence

$$B_t = -\frac{c}{N} \cot \frac{tz}{2},\ \text{and putting for } N \text{ its value 24, and for } z \text{ its value } 15^\circ,$$

$$B_1 = -\frac{c}{24} \cot (7^\circ\ 30'); \quad B_2 = -\frac{c}{24} \cot 15^\circ; \quad B_3 = -\frac{c}{24} \cot (22^\circ\ 30');$$

$$B_4 = -\frac{c}{24} \cot 30^\circ.$$

To find what value of c would make these results considerable, or would (say) give to B_1—which is the largest numerically—the value −·00001, we have

$$c = \frac{\cdot 00001 \times 24}{\cot (7^\circ\ 30')} = \cdot 000032$$

Now out of 310 months for which we have values of the increase of declination from month to month, there are only 13 for which the increase *per* day reaches this limit, and only one in which it is just doubled, whilst the average value of c for the 310 months is only ·000,004,7 or one-seventh of the limit which makes B_t considerable. Hence we conclude, as the last figure of decimals to which the coefficients are carried is the fifth, that no corrections need be applied to the coefficients on account of progressive change of declination. This applies to the coefficients of the years 1866 to 1872. For the years 1846 to 1865 we must in the general term $B_t \sin t hz$ write $(h-16)$ for h, when it becomes

$$B_t \sin t hz \cos (16\, tz) - B_t \cos t hz \sin (16\, tz),$$

so that in this case the B coefficient, due to progressive increase, will be

$$\mp \frac{c}{24} \cot \frac{t \times 15^\circ}{2} \cos (16\, tz)$$

and the A coefficient

$$\mp \frac{c}{24} \cot \frac{t \times 15^\circ}{2} \sin (16\, tz).$$

In both these the B_t of the preceding case, which was found to be negligible, is multiplied by a sine or cosine and the values of the products being numerically less than B_t, are therefore also negligible.

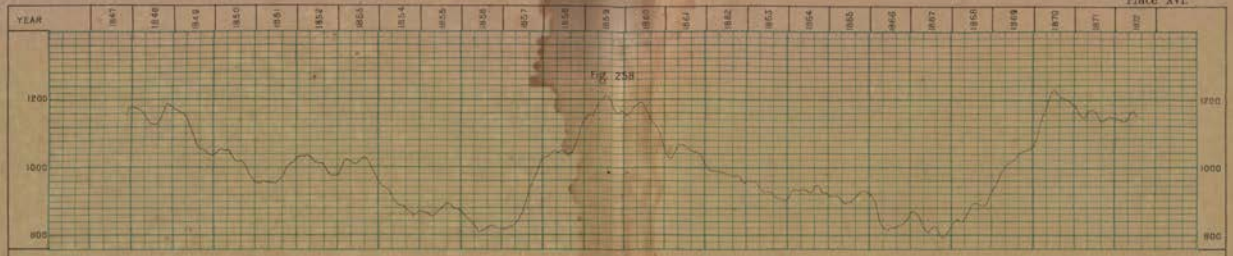
150. *Variation from year to year in the range of the mean-diurnal variation of Declination.*—These ranges for the summer and winter half-years and for the full years are shown at the feet of Tables 50 to 52, and their changes from year to year are graphically

* See Quarterly Weather Report, 1870 Appendix, page [25].

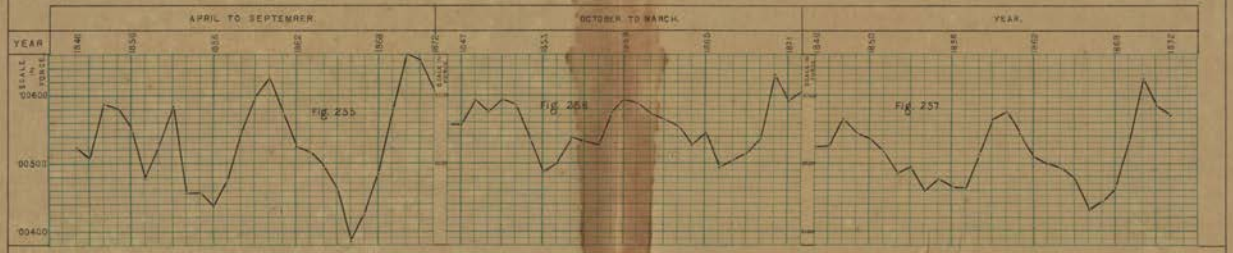
COLABA OBSERVATORY

SECULAR VARIATION OF THE DIURNAL RANGE OF DECLINATION — NINE-MONTHLY MEANS.

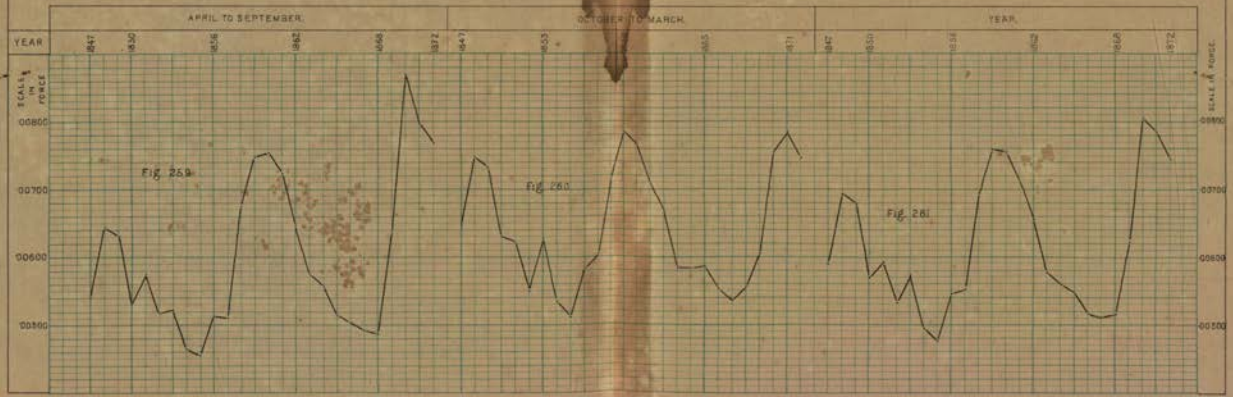
Plate XVI.



SECULAR VARIATION OF THE RANGE OF THE MEAN DIURNAL VARIATION OF DECLINATION.



SECULAR VARIATION OF THE RANGE OF THE MEAN DIURNAL VARIATION OF HORIZONTAL FORCE.



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displayed in Figs. 255 to 257 (Plate XVI). In Figs. 199 to 226 and 227 to 254 (Plates XIV and XV), the principal points to be noted are the similarity of the variations in different years, and the variation of range from year to year. The latter feature is, however, better displayed in the curves of Figs. 255 to 257, wherein the sun-spot period is, again, strongly marked: in the curve of diurnal ranges for the year the maxima occur in 1848, 1860 and 1870 and the minima in 1854-57 and 1866—the respective ranges, in order, being ·00367; ·00266; ·00376; ·00231 and ·00426,—and the curves for the separate half-years are in fair agreement with this. A more elaborate investigation of this element of the behaviour of the declination magnet has, however, been made taking for data the ranges on individual days—including the effects of disturbances. These were treated in the manner described by Dr. Balfour Stewart in the Proceedings of the Royal Society for 1877 (pages 102 to 121) and yielded nine-monthly means, at monthly intervals, of declination-range as follows:—

TABLE 54.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1847	...	...	...	...	...	...	...	...	...	...	1153	1168
1848	1176	1170	1166	1160	1144	1130	1123	1122	1134	1160	1182	1181
1849	1171	1165	1161	1155	1141	1118	1089	1061	1052	1053	1041	1035
1850	1036	1043	1050	1047	1048	1038	1018	1017	1017	1003	981	963
1851	956	957	959	958	958	957	957	963	978	1000	1006	1013
1852	1028	1031	1031	1034	1027	1015	1010	1010	1001	984	977	973
1853	974	995	1016	1020	1013	1008	1013	1019	1022	1015	997	976
1854	957	945	938	927	910	892	884	883	873	862	857	860
1855	865	863	859	855	857	866	876	887	891	882	878	878
1856	869	853	842	836	822	806	809	817	821	824	819	815
1857	815	815	819	823	833	844	863	905	935	953	983	1010
1858	1025	1025	1036.	1047	1041	1044	1043	1033	1039	1056	1083	1114
1859	1141	1153	1151	1169	1193	1200	1207	1202	1179	1159	1159	1167
1860	1161	1157	1172	1181	1187	1189	1175	1152	1134	1122	1109	1079
1861	1047	1028	1027	1045	1062	1065	1060	1050	1048	1045	1039	1025
1862	1003	993	992	990	988	984	980	977	976	975	965	957
1863	959	961	960	953	937	926	928	927	918	911	906	900
1864	908	927	934	932	933	933	927	929	943	942	927	922
1865	918	914	916	910	896	892	898	905	914	922	929	926
1866	919	906	872	838	821	818	821	821	825	829	834	850
1867	864	867	856	833	812	807	819	822	806	797	801	813
1868	830	843	842	839	854	874	888	892	887	883	891	910
1869	929	949	977	998	1009	1014	1020	1033	1042	1047	1051	1054
1870	1065	1094	1130	1163	1189	1219	1230	1216	1207	1204	1200	1191
1871	1181	1169	1152	1151	1162	1170	1164	1140	1134	1145	1148	1147
1872	1146	1140	1135	1140	1160	1166	1148	...	..	...	...	...

These ranges, which are freed by the mode of treatment from any annual variation in their value, are curved in Fig. 258 (Plate XVI). This curve is of necessity—owing to the smoothing process which has been applied to the observed numbers—freer from irregularities than the others; but they all agree in indicating the sun-spot period as that to which the variations of range are mainly related, and they all bring out distinctly the characteristic of the sun-spot curve of a rapid rise and slow fall before and after each maximum.

151. *Annual variation.*—On account of the interruptions of the record noticed in paragraph 130, and notwithstanding the attempts described in paragraph 134 to form artificial connections of broken series of observations, the monthly means of the 'final normals' are still regarded as here and there discontinuous; and, for the present purpose, the means for the months August 1851, April 1853, July 1861 and November and December 1868 have been rejected, and points of interruption have been supposed to exist at December 1, 1851; January 1, 1856; November 1, 1861; December 1, 1865; and May 1, 1866, whilst for the remaining months it was decided to see what result would follow from the assumption that each month's mean was comparable with those of the months immediately preceding and following. Table 55 exhibits the monthly means of the 'final normals' expressed in minutes of arc,—the values (f) in scale-readings for the years 1866 to 1872 having been converted by the formula $\delta = 6{\cdot}860\ (f - 28{\cdot}2733)$.

TABLE 55.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1846 ...	13·708	13·547	13·342	13·537	13·530	13·273	12·903	12·554	13·058	13·259	13·184	13·682
1847 ...	13·957	14·075	14·193	14·130	13·922	13·533	13·341	13·757	13·964	14·466	14·492	14·513
1848 ...	14·786	14·742	14·741	15·236	15·207	13·808	13·778	13·919	14·148	14·192	14·007	14·193
1849 ...	13·858	14·247	14·355	14·640	14·994	14·445	14·448	14·415	14·498	15·086	15·232	15·635
1850 ...	15·653	16·005	16·012	15·901	15·790	15·697	15·583	15·504	15·667	16·021	16·142	16·150
1851 ...	16·021	16·327	16·182	16·237	16·289	15·853	15·306	[17·542]	18·357	18·346	18·461	16·491
1852 ...	16·720	17·920	17·936	17·959	16·416	15·982	15·847	15·740	16·053	16·361	16·935	16·894
1853 ...	18·038	18·617	18·748	[15·416]	18·421	17·673	17·617	17·698	17·865	18·338	18·805	18·919
1854 ...	18·945	18·981	18·748	18·433	18·193	17·805	16·762	16·806	16·823	18·741	18·080	18·539
1855 ...	19·121	19·347	19·325	19·390	19·601	19·385	19·231	19·362	19·049	19·347	19·513	19·603
1856 ...	19·034	18·949	18·664	18·540	18·824	18·742	18·446	18·938	18·853	19·134	19·582	19·767
1857 ...	19·846	20·027	19·977	19·555	19·691	19·806	19·002	18·854	19·026	18·071	18·650	19·016
1858 ...	20·030	19·797	20·156	20·111	19·775	19·794	18·986	18·864	19·409	19·837	20·357	20·691
1859 ...	20·592	20·835	21·130	20·868	21·227	21·258	21·366	21·190	21·569	22·092	22·375	22·913
1860 ...	23·021	23·037	23·498	23·460	23·562	24·045	24·209	24·506	24·226	24·294	24·932	25·150
1861 ...	25·414	25·685	26·158	26·136	26·023	26·100	[25·902]	28·861	29·041	29·185	28·632	28·897
1862 ...	29·042	29·014	29·178	29·703	29·367	30·416	30·992	31·049	31·303	31·677	31·820	32·464
1863 ...	32·571	32·755	33·948	34·334	33·633	33·424	33·802	33·783	34·407	34·742	34·529	35·471
1864 ...	35·262	35·032	35·379	35·331	35·710	36·016	36·459	36·716	37·126	38·043	38·167	38·198
1865 ...	38·568	38·618	38·680	37·816	39·004	39·499	40·143	41·251	41·489	41·717	41·241	42·311
1866 ...	42·600	42·880	42·970	43·210	43·828	43·896	44·321	44·396	45·096	45·281	45·604	45·851
1867 ...	45·817	46·064	46·441	46·393	46·572	46·695	46·866	46·633	46·887	47·175	47·312	47·449
1868 ...	47·751	48·081	48·280	48·801	48·945	48·959	49·137	49·562	50·146	50·632	[50·166]	[50·166]
1869 ...	49·534	49·830	50·111	50·372	50·866	50·886	50·873	51·277	51·634	51·634	51·737	51·819
1870 ...	52·176	52·224	52·608	52·780	52·574	52·533	52·725	53·376	54·199	54·330	54·495	54·440
1871 ...	54·632	54·899	55·112	55·002	54·790	54·556	54·811	55·256	55·359	55·585	55·903	56·038
1872 ...	56·313	56·491	56·491	56·477	56·347	56·306	56·114	56·505	56·443	56·882	57·184	57·080

Rejected months' means are enclosed in square brackets, and interruptions are marked by strong vertical lines.

152. The operations performed upon these numbers were (1) to take their differences for each month and the next following month, (2) to take the monthly means of these differences for all the years, (3) to take the sum of the twelve monthly means and regard it as representing the mean secular change *per* year of the period, (4) to subtract one-twelfth of this sum from each of the monthly means and regard the differences as due entirely to the annual variation, (5) writing *zero* for the month of January to add successively the last found differences and find a series of accumulated changes from the month of January to each other month in succession, (6) to take the variation of these accumulations, and (7) to convert this variation into force and regard it as representing the annual variation of declination. These operations were performed for the whole period 1846 to 1872 and for the subordinate periods 1846 to 1858, 1859 to 1866, and 1867 to 1872 separately, with the results shown in the following table. The table also exhibits the several values of the secular increase *per* year, the periods having been chosen so that this should be approximately constant throughout each single period.

TABLE 56.

Annual variation of east magnetic force.

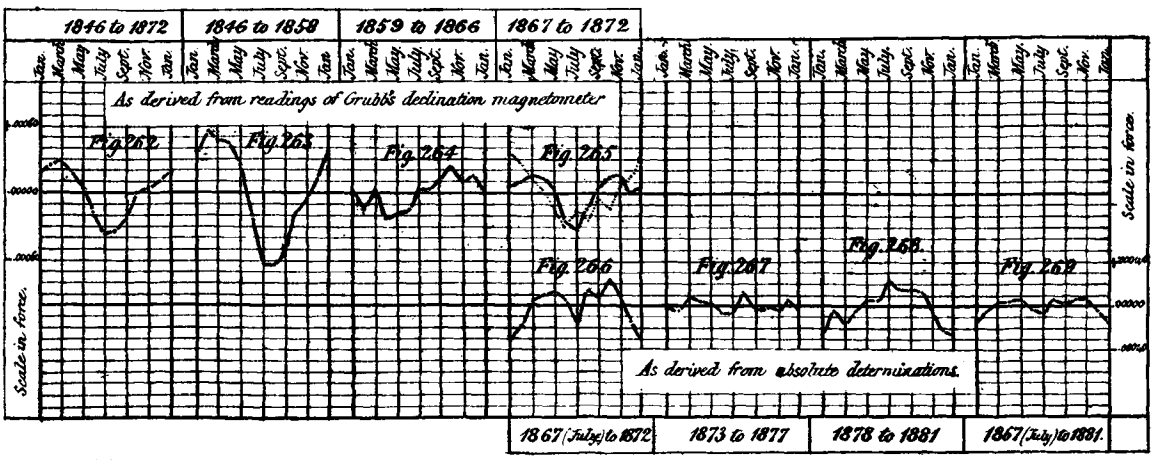
Period.	January.	Feby.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Secular increase *per* year.
1846 to 1858.	+·00037	+·00055	+·00048	+·00043	+·00025	−·00020	−·00062	−·00063	−·00050	−·00019	−·00006	+·00011	+·00063
1859 to 1866.	+·00002	−·00013	+·00004	− 00023	−·00019	−·00014	+·00003	+·00002	+·00011	+·00023	+·00010	+·00014	+·00303
1867 to 1872.	+·00005	+·00010	+·00017	+·00012	−·00002	−·00025	−·00033	−·00015	+·00003	−·00012	+·00016	·00000	+·00230
1846 to 1872.	+·00019	+·00025	+·00028	+·00017	+·00006	−·00019	−·00038	−·00034	−·00021	·00000	+·00004	+·00010	+·00169

153. The same operations were performed upon the monthly mean readings of the declination magnetometer—inclusive of all disturbances, and with the following results, which are practically identical with those of Table 56.

TABLE 57.

Period.	January.	Feby.	March.	April.	May.	June.	July.	August.	Sept.	October.	Novr.	Decr.
1846 to 1858.	+·00035	+·00057	+·00051	+·00043	+·00023	−·00022	−·00063	−·00065	−·00051	−·00019	−·00003	+·00013
1859 to 1866.	+·00011	+·00001	+·00018	−·00012	−·00025	−·00026	−·00010	−·00003	+·00005	+·00018	+·00001	+·00022
1867 to 1872.	+·00003	+·00011	+·00017	+·00015	−·00004	−·00025	−·00036	−·00015	+·00004	+·00020	+·00014	−·00003
1846 to 1872.	+·00013	+·00024	+·00029	+·00019	+·00002	−·00023	−·00040	−·00032	−·00017	+·00008	+·00012	+·00003

Annual Variation of Declination.



154. The numbers of Table 56 are curved in Figs. 262 to 265. We first remark upon the curves that the range of them is very small, that for the first period scarcely exceeding the equivalent of a minute of arc in the whole year, and that for the last period not quite reaching the half of this: the first and last periods agree in making a minimum about July a principal feature and a maximum about March a marked feature of the variation; but the curve of the middle period, though of still smaller range and therefore less significant, has little in common with the other two.

155. For comparison with these results we have applied the same process to the mean *observed* values of *absolute* declination in each month after correction of these for the difference of declination—as shown by the declination magnetometer—between the times of observation and the mean declination of the month. The corrected monthly means as well the yearly averages and the increments for the several years are shown in Table 58.

TABLE 58.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Novr.	Decr.	Year.	Annual increment.
1867 ...	...	...	...	...	...	...	′ ″ 43 16	′ ″ 43 6	′ ″ 43 35	′ ″ 43 56	′ ″ 44 19	′ ″ 43 58	...	...
1868 ...	′ ″ 44 8	′ ″ 43 54	′ ″ 44 52	′ ″ 45 14	′ ″ 44 26	′ ″ 44 43	44 38	45 38	45 31	46 1	45 56	45 42	′ ″ 45 4	′ ″ +2 25
1869 ...	45 55	47 0	47 15	47 30	47 37	47 49	47 23	47 47	47 38	47 47	47 50	48 20	47 29	+1 52
1870 ...	48 27	48 14	48 33	48 55	48 51	48 57	49 16	49 39	50 35	50 37	50 7	50 8	49 21	+1 §2
1871 ...	49 52	50 26	50 46	51 3	50 53	50 44	51 3	51 37	51 22	52 1	52 28	52 21	51 13	+1 50
1872 ...	52 26	52 43	52 52	52 52	52 40	52 48	52 38	53 13	53 12	53 43	53 45	53 47	53 3	+0 57
1873 ...	53 51	53 43	53 49	53 55	53 51	54 2	54 14	54 36	54 12	54 0	53 56	53 48	54 0	+0 27
1874 ...	53 37	53 59	54 8	54 19	54 19	54 40	54 31	54 32	54 23	54 55	54 52	55 4	54 27	+0 54
1875 ...	55 0	55 6	55 21	55 22	55 38	55 14	55 24	55 27	55 14	55 9	55 28	55 49	55 21	+0 37
1876 ...	55 48	55 56	55 50	55 37	55 33	55 32	55 46	56 9	56 22	56 22	56 19	56 25	55 58	+0 41
1877 ...	56 37	56 17	56 42	56 37	56 41	56 30	56 21	56 34	56 46	56 52	56 51	57 1	56 39	+0 27
1878 ...	57 0	57 21	57 10	57 13	56 57	57 7	57″ 1	56 40	56 51	57 7	57 20	57 28	57 6	+0 24
1879 ...	57 35	57 32	57 33	57 26	57 30	57 35	57 51	57 40	57 51	57 6	57 8	57 15	57 30	−0 21
1880 ...	57 9	57 3	56 53	56 55	56 59	57 4	57 14	57 28	57 12	57 8	57 23	57 20	57 9	+0 3
1881 ...	56 59	57 24	57 1	57 24	57 43	57 10	57 21	57 12	56 56	57 9	57 28	56 32	57 12	

These numbers may be treated as independent data because they are independent of the changes that occur from month to month and from year to year in the readings of the declination magnetometer, that is to say it is assumed that such changes are likely to be of pure magnetic origin in a less degree than those that occur in the course of a single month.

156. Subordinate periods were, in this case, taken from 1867 (July) to 1872, from 1873 to 1877, and from 1878 to 1881. The results were as follows:—

TABLE 59.

Annual variation of east magnetic force.

Period.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1867 (July) to 1872 ...	—·00030	—·00019	+·00004	+·00010	+·00013	+·00004	—·00018	+·00011	+·00006	+·00024	+·00009	—·00015
1873 to 1877	—·00001	—·00004	+·00008	+·00002	+·00001	—·00008	—·00006	+·00011	—·00003	—·00001	—·00004	+·00005
1878 to 1881	—·00025	—·00003	—·00018	—·00004	+·00006	+·00005	+·00023	+·00016	+·00016	+·00012	—·00006	—·00021
1867 (July) to 1881...	—·00014	—·00006	+·00001	+·00003	+·00005	—·00003	—·00006	+·00008	+·00001	+·00007	+·00007	—·00004

The numbers of this table are curved in Figs. 266 to 269.

157. In none of these periods does the range of the variation exceed the equivalent of half a minute of arc, but the differences in the character of the variation exhibited within that small range are such as to throw doubt on the reality of the phenomenon as a magnetic one, and to imply that it is, perhaps, mainly instrumental error. As the number of absolute observations made in a month is only four or five, as against some 600 in the case of the declination magnetometer, we cannot expect the same regularity in these results as in those obtained above, and the average inequalities of the variations of the several periods do not greatly exceed the probable errors of observation of the corresponding absolute determinations.*

158. Another view of the matter would, however, be that the annual variation—as a true magnetic phenomenon—is different in the different periods, and is approximately represented by the several curves. In this case, comparing the figures (265 and 266) for the period 1867 to 1872, we must attribute the greater part of the variation shown by the former curve to other than magnetic affections of the instrument, and the magnitude of these other affections will be more distinctly brought out by subtracting the numbers, for the period in question, in Table 59 from those in Table 56. The differences thus found are curved in the dotted line of Fig. 265, and they show a decided minimum in June, July and August, and a decided maximum about the winter solstice, with a gradual progression from each to the other. The dryness of the air at Bombay follows a similar order of change, so that we may, perhaps, fairly infer that the principal cause of the variations shown in the dotted line of Fig. 265 is variation in the hygrometric condition of the bunch of silk fibres which supports the declination magnet. The definite conclusion of value to which the discussion leads is, however, that in any case the annual variation of east magnetic force is exceedingly small. In going beyond this, other points worth consideration, in addition to those already referred to, are (1) that if for the period 1867 to 1872 (Fig. 265) the variations observed be attributed to hygrometric action in the suspension threads, the moist or dry air must be supposed to have had freer access to the threads in the period 1846 to 1858 than in 1867 to 1872, since the curve of the former period (Fig. 263) is more open than that of the latter (Fig. 265); (2) the contrary supposition must be entertained in regard to the middle period (Fig. 264); and (3) if we attribute the comparative irregularity of Fig. 264 to the unknown changes of collimation of the reading telescope, referred to in paragraph 125, we must suppose Fig. 263 to be affected in less degree in the same way, seeing that the period of doubtful settings of the telescope extended from 1853 to 1866.

159. *Secular change.*—The annual mean values of absolute declination and the yearly increments of declination, are shown—for the years 1868 to 1881—in the last two columns of Table 58. The rate of increase from 1868 to 1872 is 2′·0 per year, the equivalent of which in east magnetic force is +·00216 *mm-mg-s unit*. This agrees well with the value (+·00230) for the years 1867 to 1872 given by the declination magnetometer alone, and such agreement forms some ground for confidence in the general accuracy of the values (+·00063 and +·00303), obtained also from the readings of the declination magnetometer alone, for the periods 1846 to 1858 and 1859 to 1866. (See last column of Table 56). It will be observed from the last column but one of Table 58 that the absolute easterly declination reached a maximum in 1879 and has since decreased.

* See Philosophical Transactions, Vol. 166, page 82.

160. *Lunar diurnal variations.*—The data used for this investigation are the observations of the twenty-five years 1846 to 1870. The method of treatment of the observations is the same as that adopted by General Sir Edward Sabine for those of the Colonial magnetic observatories. From the monthly tables, described in paragraph 131, all observations having been thrown out which deviated from the "Final Normal" of each hour by more than 1'·4, new tables were formed in which each observation was substituted by its excess above the Final Normal of its own hour; or rather by that excess *plus* 2'·0. Practically, the Final Normal was diminished by 2'·0, and the difference being then taken between the number found and each observation in the same hour column, all the differences have the *positive* sign, and thus the inconvenience of dealing with *positive* and *negative* numbers is avoided. On the new tables the observation at the solar hour of each day which was nearest to the time of the moon's crossing the meridian of Bombay (from East to West) was marked with a figure 0 to indicate that that observation must be placed to the 0th hour of the lunar day in tables having the lunar hours, from 0 to 23, marked in consecutive order at the top of the several columns. If only twenty-three observations intervened between two marked ones, they were entered in the table consecutively as forming a complete lunar day: but as twenty-four observations generally intervened, the two which were in the nearest correspondence to the same lunar hour were combined together, and the mean of the two treated as a single observation.

161. Sixty-four varieties of lunar tables were recognized, as shown in the following form:—

Quarter of Year.	November to January.															
Declination of Moon.	North.				Changing from North to South.				South.				Changing from South to North.			
Phase of Moon.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.
Number of Variety ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Quarter of Year.	February to April.															
Declination of Moon.	North.				Changing from North to South.				South.				Changing from South to North.			
Phase of Moon.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.
Number of Variety ...	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Quarter of Year.	May to July.															
Declination of Moon.	North.				Changing from North to South.				South.				Changing from South to North.			
Phase of Moon.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.
Number of Variety ...	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48

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Quarter of Year.	August to October.															
Declination of Moon.	North.				Changing from North to South.				South.				Changing from South to North.			
Phase of Moon.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.	New.	First Quarter.	Full.	Last Quarter.
Number of Variety ...	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64

162. A little consideration will show, however, that only forty-eight of these varieties have counterparts in actual phenomena, and that in sixteen of these the occurrences far outweigh those of the remaining thirty-two. As the path of the moon deviates but little from the plane of the ecliptic, we may suppose it to move in that plane. At the summer solstice we shall then have new moon and the moon's maximum north declination occurring together, first quarter and the moon's passage from north to south declination together, full moon and the moon's maximum south declination together, and last quarter and the moon's passage from south to north declination together; and similar simultaneous occurrences at the autumnal equinox, at the winter solstice and at the spring equinox—bringing the simultaneities up to sixteen in all. But in classifying lunar days according to the concurrence of quarters of the year, phases of the moon and declination of the moon, one of each together, and in giving duration of a quarter of a period to each phenomenon (roughly speaking from an eighth of a period before to an eighth of a period after the epochs of the solstices and equinoxes, &c., &c.) we shall have the phases of one quarter of the year occurring not only during the corresponding declination of the moon, but entering also the categories of the preceding and following declinations, and the proportion of such overlapping occurrences to the whole number will be one-half at the beginning of the quarter, none in the middle, and one-half at the end of the quarter; or of the total number of occurrences about three-fourths will be classed with the corresponding declination and about one-fourth will overlap at one side or the other. From May to July, for instance, new moon should comprise about six times as many occurrences in the category of moon's declination north as in either of the categories moon passing from south to north or moon passing from north to south: and similarly moon's declination north should comprise about six times as many occurrences under the category new moon as under either of the categories first quarter or last quarter. For each of the sixteen principal categories there will, however, be two subordinate categories making forty-eight in all; but the weight of the results for the former categories will be about six times as great as the weight of the results for the subordinate categories.

163. From 1846 to 1865 the first tables of differences, having the hours of Göttingen astronomical time marked at the head of the columns, the Göttingen times of the Moon's passage from North to South or South to North declination, and of New Moon and Full Moon were marked on the margin of the sheet opposite to the several corresponding solar days: for 1866 to 1870 the same was done on tables having the hours of Bombay civil time marked at the head of the columns, the times of the lunar phenomena being marked in Bombay civil time. For the days so marked, and for three days before and after, the moon was regarded as "changing from North to South" declination; "changing from South to North" declination; as "New;" or at "Full" respectively; and during the intervening days the designations of the moon's position or phase were "South" declination; "North" declination; "First Quarter"; and "Last Quarter" respectively. The whole of a lunar day's differences were entered in the lunar abstracts under that variety of position to which the greater half of the day belonged. Whenever the number of undisturbed observations on a lunar day was less than twelve, the whole day's differences were rejected. When all the differences of each category had been entered on their respective lunar tables, the hourly means were taken on these tables; and the excess was then found of each of these means above the mean of all the hours. The series of hourly excesses thus found may, in a sufficiently extended inquiry, be taken to represent the lunar diurnal variation of Declination when the sun and moon have the positions indicated by that particular table.

164. The following tables show the hourly excesses found on each of the forty-eight lunar abstracts:—

TABLE 60.

DECLINATION OF MOON.	NORTH.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hour.*	February to April.	May to July.	August to October.	November to January.	February to April.	May to July.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.
	1	2	3	4	5	6	7	8	9	10	11	12
0	−·00015	−·00020	−·00022	+·00011	+·00004	−·00005	+·00008	+·00001	+·00008	+·00007	−·00020	−·00006
1	−·00018	−·00016	−·00006	+·00006	+·00006	·00000	+·00003	+·00004	+·00016	+·00097	−·00012	−·00004
2	−·00015	−·00009	−·00001	−·00002	+·00006	+·00006	+·00005	−·00002	+·00011	+·00013	+·00007	−·00001
3	−·00002	+·00004	+·00014	+·00003	+·00001	+·00009	−·00001	−·00004	+·00010	+·00017	+·00009	+·00004
4	−·00002	+·00004	+·00026	−·00006	−·00001	+·00001	−·00004	−·00005	+·00001	+·00024	+·00022	+·00015
5	+·00001	+·00015	+·00022	−·00012	−·00005	+·00005	−·00007	−·00008	−·00005	+·00010	+·00018	+·00020
6	−·00001	+·00010	+·00016	−·00012	−·00004	+·00006	−·00015	−·00007	−·00001	−·00004	+·00012	+·00013
7	+·00008	+·00004	+·00006	−·00002	−·00006	·00000	−·00016	−·00007	−·00015	−·00014	+·00006	+·00004
8	+·00006	+·00002	−·00004	+·00001	−·00005	−·00003	−·00019	+·00001	−·00019	−·00019	+·00012	−·00004
9	+·00006	−·00001	−·00006	−·00009	−·00004	−·00004	−·00015	+·00004	−·00036	−·00022	−·00011	−·00011
10	+·00010	+·00002	−·00003	−·00007	−·00001	−·00009	−·00005	+·00004	−·00012	−·00018	−·00032	−·00010
11	+·00013	+·00002	−·00002	−·00001	+·00006	−·00014	+·00007	−·00002	+·00005	+·00001	−·00019	−·00006
12	+·00017	−·00001	−·00002	+·00019	+·00007	−·00008	+·00017	+·00001	+·00007	−·00001	−·00008	−·00002
13	+·00013	−·00001	−·00003	+·00016	+·00003	−·00008	+·00019	+·00001	−·00010	+·00010	+·00006	+·00004
14	−·00001	·00000	−·00004	+·00031	+·00002	−·00008	+·00016	+·00010	+·00009	+·00005	+·00003	+·00002
15	+·00004	·00000	−·00007	+·00024	·00000	−·00008	+·00013	−·00002	−·00001	+·00005	+·00006	+·00001
16	−·00005	+·00002	·00000	·00000	+·00001	−·00002	+·00001	−·00009	−·00002	−·00004	+·00003	+·00001
17	+·00003	+·00007	−·00081	+·00010	−·00004	+·00017	−·00009	+·00011	+·00005	·00000	+·00004	·00000
18	−·00001	+·00011	+·00008	−·00007	−·00008	+·00020	−·00003	−·00001	+·00009	−·00003	+·00009	+·00001
19	+·00004	+·00011	+·00014	−·00038	−·00004	+·00017	−·00003	+·00008	+·00007	−·00004	+·00003	−·00006
20	−·00003	+·00004	+·00011	−·00021	−·00004	+·00012	+·00001	+·00002	+·00005	−·00005	−·00001	·00000
21	+·00001	−·00005	−·00001	−·00012	+·00004	−·00010	+·00002	+·00002	+·00001	−·00005	+·00005	−·00003
22	−·00007	−·00011	−·00025	+·00006	+·00002	−·00002	+·00002	−·00001	+·00004	−·00009	−·00012	−·00004
23	−·00017	−·00015	−·00031	+·00002	+·00003	−·00011	+·00001	−·00001	·00000	+·00008	−·00009	−·00009
Coefficients. A_1 ...	+·00011	+·00005	+·00002	+·00007	−·00001	−·00004	+·00001	+·00001	−·00007	−·00006	−·00002	·00000
B_1 ...	−·00001	−·00001	−·00005	+·00001	·00000	+·00002	+·00007	+·00003	+·00006	·00000	−·00002	−·00003
A_2 ...	+·00002	+·00010	+·00013	−·00011	−·00005	+·00009	−·00010	−·00001	−·00003	−·00003	+·00012	+·00005
B_2 ...	+·00003	−·00001	−·00005	−·00010	−·00001	−·00002	−·00006	+·00001	−·00007	−·00012	−·00008	−·00006
A_2' ...	+·00005	+·00005	−·00010	−·00006	+·00001	+·00001	+·00004	·00000	+·00004	+·00005	+·00004	+·00004
B_3 ...	·00000	−·00001	−·00003	+·00006	·00000	−·00005	+·00002	−·00002	−·00002	+·00001	+·00005	+·00004
Number of lunar days' observations in abstract	38	323	70	42	329	61	302	58	34	70	41	324

* The lunar day is reckoned as beginning at the moment of the moon's upper passage of the meridian.

Table 61.

Declination of Moon.	Changing from North to South.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hour.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.	November to January.	February to April.	May to July.	November to January.	February to April.	August to October.
	1	2	3	4	5	6	7	8	9	10	11	12
0	+ ·00006	− ·00025	− ·00017	+ ·00002	− ·00010	− ·00025	− ·00004	− ·00001	− ·00001	+ ·00007	+ ·00008	− ·00019
1	+ ·00006	− ·00026	− ·00010	− ·00002	− ·00004	− ·00015	·00000	− ·00001	− ·00003	+ ·00010	+ ·00014	− ·00018
2	+ ·00017	+ ·00005	+ ·00001	− ·00001	+ ·00001	+ ·00002	− ·00001	− ·00004	·00000	+ ·00009	+ ·00013	− ·00008
3	+ ·00007	+ ·00001	+ ·00008	− ·00002	+ ·00001	+ ·00009	− ·00005	− ·00006	+ ·00003	+ ·00010	− ·00007	+ ·00001
4	+ ·00004	+ ·00001	+ ·00013	− ·00003	− ·00001	+ ·00002	− ·00008	− ·00010	− ·00003	− ·00001	− ·00013	− ·00004
5	− ·00010	+ ·00008	+ ·00009	− ·00018	·00000	+ ·00002	− ·00023	− ·00009	− ·00003	− ·00008	− ·00024	+ ·00010
6	− ·00016	− ·00005	+ ·00003	− ·00010	− ·00002	− ·00002	− ·00016	− ·00008	·00000	− ·00013	− ·00007	+ ·00022
7	− ·00024	+ ·00002	− ·00002	− ·00008	− ·00003	+ ·00001	− ·00007	+ ·00001	+ ·00006	− ·00015	− ·00001	+ ·00009
8	− ·00010	+ ·00008	·00000	− ·00006	− ·00004	− ·00004	− ·00019	+ ·00010	+ ·00008	− ·00014	− ·00008	− ·00002
9	− ·00001	+ ·00015	− ·00001	+ ·00004	− ·00004	+ ·00006	+ ·00002	+ ·00009	− ·00003	− ·00010	− ·00003	− ·00001
10	·00000	+ ·00009	+ ·00003	+ ·00014	− ·00004	− ·00009	+ ·00003	+ ·00010	− ·00008	·00000	+ ·00002	+ ·00001
11	+ ·00002	+ ·00015	+ ·00001	+ ·00015	− ·00008	− ·00010	+ ·00015	+ ·00006	− ·00009	+ ·00008	+ ·00006	+ ·00001
12	+ ·00002	+ ·00013	·00000	+ ·00002	− ·00012	− ·00006	+ ·00021	+ ·00004	− ·00014	+ ·00007	+ ·00007	+ ·00001
13	+ ·00002	+ ·00005	·00000	− ·00010	− ·00011	− ·00007	+ ·00020	− ·00005	− ·00021	+ ·00006	+ ·00005	+ ·00001
14	+ ·00004	− ·00002	+ ·00003	+ ·00005	− ·00007	+ ·00002	+ ·00014	− ·00005	− ·00008	+ ·00002	− ·00004	+ ·00008
15	+ ·00007	+ ·00003	+ ·00004	− ·00012	+ ·00006	+ ·00023	+ ·00002	− ·00002	+ ·00011	·00000	+ ·00004	+ ·00013
16	+ ·00001	+ ·00005	+ ·00008	− ·00009	+ ·00019	+ ·00033	− ·00013	·00000	+ ·00021	− ·00002	+ ·00006	+ ·00005
17	− ·00003	+ ·00011	+ ·00009	+ ·00014	+ ·00018	+ ·00020	− ·00008	+ ·00001	+ ·00024	− ·00001	·00000	·00000
18	·00000	+ ·00025	+ ·00004	+ ·00021	+ ·00015	+ ·00009	− ·00004	+ ·00001	+ ·00020	− ·00002	− ·00002	+ ·00002
19	+ ·00005	+ ·00016	+ ·00005	+ ·00009	+ ·00016	+ ·00008	+ ·00001	− ·00001	+ ·00006	− ·00002	− ·00004	− ·00001
20	+ ·00005	− ·00003	− ·00001	+ ·00007	+ ·00013	− ·00005	+ ·00005	+ ·00002	− ·00008	− ·00003	− ·00003	− ·00003
21	+ ·00001	− ·00027	− ·00009	+ ·00005	− ·00001	− ·00008	+ ·00012	+ ·00003	− ·00008	+ ·00003	+ ·00001	− ·00009
22	− ·00003	− ·00024	− ·00014	− ·00011	− ·00007	− ·00013	+ ·00005	+ ·00001	− ·00004	+ ·00004	+ ·00001	− ·00004
23	− ·00001	− ·00032	− ·00016	− ·00005	− ·00008	− ·00014	+ ·00008	+ ·00004	− ·00006	+ ·00004	+ ·00007	− ·00006
Coefficients. A_1 ...	− ·00003	+ ·00014	+ ·00005	+ ·00002	− ·00001	+ ·00006	+ ·00004	+ ·00002	− ·00001	− ·00003	·00000	+ ·00007
B_1 ...	+ ·00004	− ·00001	− ·00001	+ ·00005	+ ·00007	+ ·00005	+ ·00006	+ ·00001	+ ·00004	+ ·00003	+ ·00004	− ·00002
A_2 ...	− ·00006	+ ·00009	+ ·00006	·00000	+ ·00009	+ ·00011	− ·00011	− ·00002	+ ·00010	− ·00008	− ·00008	+ ·00006
B_2 ...	− ·00004	− ·00003	− ·00005	+ ·00004	− ·00002	− ·00009	+ ·00003	+ ·00006	− ·00004	− ·00004	·00000	− ·00002
A_3 ...	+ ·00003	+ ·00005	+ ·00004	+ ·00002	− ·00001	− ·00003	+ ·00006	− ·00002	− ·00008	+ ·00003	− ·00004	+ ·00001
B_3 ...	·00000	− ·00010	− ·00003	− ·00009	− ·00004	− ·00003	+ ·00001	− ·00002	− ·00004	− ·00003	− ·00003	+ ·00005
Number of lunar days' observations in abstract	79	50	343	54	365	90	57	322	74	335	74	44

TABLE 62.

DECLINATION OF MOON.	SOUTH.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hour.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.	November to January.	February to April.	May to July.
	1	2	3	4	5	6	7	8	9	10	11	12
0	+ ·00018	+ ·00009	− ·00001	+ ·00011	+ ·00010	− ·00002	+ ·00004	− ·00004	− ·00006	+ ·00022	+ ·00007	− ·00002
1	+ ·00025	+ ·00006	+ ·00001	+ ·00001	+ ·00005	− ·00001	+ ·00003	+ ·00003	− ·00003	+ ·00024	+ ·00004	− ·00014
2	+ ·00016	+ ·00009	+ ·00007	+ ·00004	− ·00006	+ ·00003	+ ·00003	+ ·00003	+ ·00005	+ ·00026	− ·00004	− ·00015
3	+ ·00009	+ ·00014	− ·00002	− ·00004	− ·00004	+ ·00001	+ ·00004	− ·00001	+ ·00009	− ·00007	− ·00009	− ·00001
4	− ·00003	+ ·00013	− ·00010	− ·00006	− ·00018	+ ·00003	+ ·00003	+ ·00001	+ ·00003	− ·00021	− ·00010	+ ·00006
5	− ·00009	+ ·00005	− ·00002	− ·00008	− ·00011	·00000	+ ·00001	+ ·00007	+ ·00005	− ·00022	+ ·00003	+ ·00018
6	− ·00011	− ·00002	− ·00006	− ·00005	− ·00010	+ ·00001	+ ·00004	+ ·00007	+ ·00008	− ·00022	+ ·00002	+ ·00015
7	− ·00011	− ·00010	+ ·00002	− ·00004	− ·00001	− ·00002	+ ·00007	+ ·00004	+ ·00009	− ·00023	+ ·00010	+ ·00004
8	− ·00006	− ·00010	− ·00004	− ·00007	− ·00005	− ·00002	+ ·00003	+ ·00008	+ ·00001	− ·00021	+ ·00003	+ ·00008
9	− ·00002	− ·00003	− ·00006	− ·00004	− ·00014	− ·00003	− ·00001	+ ·00002	− ·00005	− ·00015	+ ·00001	+ ·00004
10	+ ·00002	+ ·00003	+ ·00002	− ·00001	+ ·00002	− ·00001	− ·00007	− ·00014	− ·00015	+ ·00003	− ·00003	− ·00007
11	·00000	+ ·00002	− ·00003	+ ·00003	+ ·00001	− ·00005	− ·00009	− ·00013	− ·00020	+ ·00004	+ ·00001	− ·00005
12	+ ·00002	+ ·00013	− ·00003	+ ·00009	− ·00010	− ·00002	− ·00024	− ·00018	− ·00013	+ ·00002	+ ·00002	− ·00004
13	+ ·00004	·00000	+ ·00001	+ ·00006	− ·00004	+ ·00005	− ·00016	− ·00012	− ·00019	+ ·00005	+ ·00002	+ ·00001
14	+ ·00001	+ ·00009	− ·00003	+ ·00004	− ·00015	+ ·00007	− ·00015	− ·00004	− ·00003	·00000	+ ·00006	+ ·00001
15	·00000	+ ·00004	− ·00003	+ ·00001	− ·00004	+ ·00007	− ·00009	+ ·00004	− ·00002	·00000	− ·00001	− ·00008
16	− ·00001	+ ·00001	− ·00018	+ ·00007	− ·00001	+ ·00008	+ ·00013	+ ·00008	+ ·00015	− ·00004	+ ·00001	− ·00005
17	− ·00005	− ·00006	− ·00019	+ ·00007	+ ·00021	+ ·00007	+ ·00006	+ ·00009	+ ·00021	+ ·00002	− ·00001	− ·00001
18	− ·00012	− ·00015	− ·00012	− ·00006	+ ·00034	+ ·00007	+ ·00007	+ ·00008	+ ·00005	+ ·00001	− ·00004	− ·00002
19	− ·00014	− ·00021	− ·00004	− ·00006	+ ·00025	+ ·00005	·00000	·00000	+ ·00003	+ ·00004	− ·00007	·00000
20	− ·00009	− ·00024	+ ·00010	− ·00005	+ ·00013	− ·00003	+ ·00005	+ ·00001	− ·00007	+ ·00005	− ·00003	− ·00002
21	− ·00007	− ·00006	+ ·00023	+ ·00004	+ ·00005	− ·00012	+ ·00007	+ ·00001	+ ·00001	+ ·00010	− ·00001	+ ·00003
22	+ ·00002	+ ·00005	+ ·00036	+ ·00005	− ·00007	− ·00012	+ ·00007	− ·00001	+ ·00003	+ ·00016	·00000	+ ·00005
23	+ ·00011	+ ·00005	+ ·00015	− ·00005	− ·00008	− ·00009	+ ·00003	+ ·00002	+ ·00002	+ ·00012	+ ·00003	+ ·00001
Coefficients. A_1 ...	− ·00005	− ·00001	− ·00003	+ ·00001	− ·00003	− ·00003	− ·00008	− ·00004	− ·00005	− ·00008	+ ·00001	·00000
Coefficients. B_1 ...	− ·00002	− ·00005	+ ·00001	+ ·00003	+ ·00011	+ ·00001	·00000	·00000	+ ·00001	+ ·00010	− ·00001	− ·00004
Coefficients. A_2 ...	− ·00011	− ·00009	− ·00007	− ·00005	+ ·00005	+ ·00003	+ ·00006	+ ·00007	+ ·00009	− ·00013	− ·00002	+ ·00005
Coefficients. B_2 ...	− ·00004	− ·00008	+ ·00008	− ·00002	+ ·00003	− ·00006	+ ·00001	− ·00002	− ·00004	·00000	+ ·00001	+ ·00002
Coefficients. A_3 ...	− ·00004	·00000	+ ·00003	− ·00001	− ·00001	− ·00001	− ·00004	− ·00005	− ·00005	− ·00001	− ·00003	+ ·00002
Coefficients. B_3 ...	− ·00002	+ ·00002	+ ·00007	− ·00001	− ·00009	− ·00002	− ·00001	+ ·00001	+ ·00001	− ·00005	+ ·00003	+ ·00006
Number of lunar days' observations in abstract	293	59	36	77	50	337	37	331	63	52	334	70

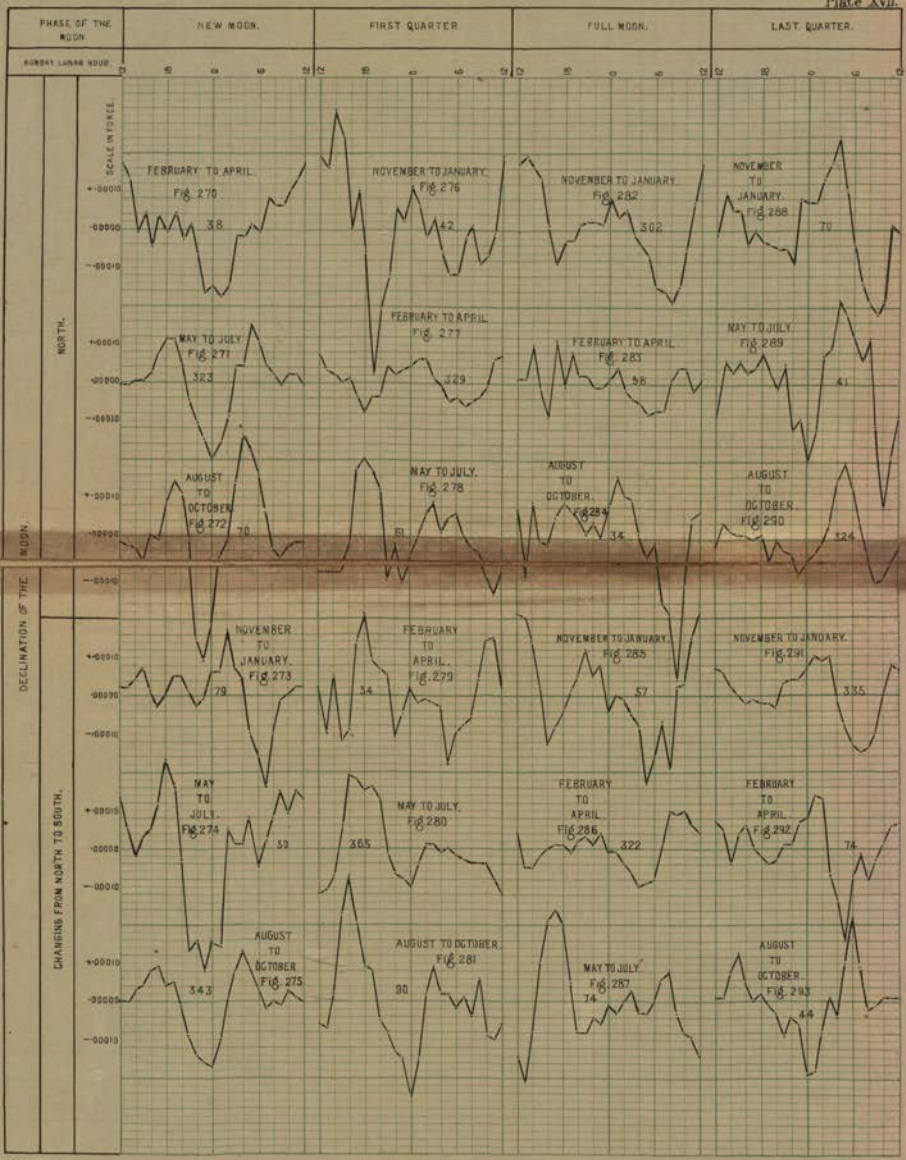
Table 63.

Declination of Moon.	Changing from South to North.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hour.	November to January.	February to April.	May to July.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.
	1	2	3	4	5	6	7	8	9	10	11	12
0	+·00011	−·00003	−·00023	+·00014	+·00013	−·00001	+·00005	−·00001	−·00002	+·00001	−·00007	+·00002
1	+·00020	−·00004	−·00028	+·00012	+·00004	+·00003	+·00011	+·00001	·00000	−·00009	−·00010	+·00007
2	+·00018	−·00003	−·00017	+·00006	+·00005	+·00003	+·00008	−·00003	+·00005	−·00008	−·00005	+·00001
3	−·00008	−·00002	−·00004	+·00003	−·00003	+·00009	+·00005	−·00003	+·00004	−·00022	+·00004	−·00001
4	−·00026	+·00001	−·00005	+·00003	−·00006	+·00002	+·00003	+·00007	+·00001	−·00019	+·00005	+·00013
5	−·00019	−·00001	+·00012	·00000	−·00005	−·00011	−·00001	+·00009	+·00005	−·00007	+·00007	+·00011
6	−·00021	−·00001	+·00011	−·00004	−·00005	−·00006	−·00005	+·00006	+·00005	·00000	+·00014	+·00006
7	−·00006	−·00006	+·00003	−·00003	−·00003	−·00003	−·00007	+·00011	+·00005	−·00001	+·00015	+·00006
8	−·00004	−·00009	−·00006	−·00005	−·00006	−·00002	−·00003	+·00003	−·00001	−·00008	+·00009	+·00009
9	−·00004	−·00004	−·00004	−·00008	−·00004	−·00007	−·00008	−·00015	−·00004	+·00001	−·00005	+·00001
10	+·00004	+·00001	−·00001	−·00001	−·00006	−·00018	−·00010	−·00012	−·00016	+·00004	−·00014	−·00021
11	+·00006	+·00003	−·00005	+·00004	−·00004	−·00024	−·00007	−·00019	−·00013	+·00002	−·00009	−·00024
12	+·00006	+·00008	+·00001	+·00005	·00000	−·00009	−·00011	−·00027	−·00006	+·00001	−·00008	−·00018
13	+·00015	+·00005	−·00003	+·00008	+·00002	−·00004	+·00001	−·00018	−·00005	+·00013	+·00001	−·00013
14	+·00003	+·00008	+·00002	+·00004	−·00004	·00000	+·00009	−·00008	+·00004	+·00009	+·00004	−·00001
15	+·00006	+·00005	+·00004	+·00006	−·00006	+·00007	+·00011	+·00002	+·00012	·00000	·00000	−·00004
16	−·00002	+·00002	+·00001	−·00003	−·00005	+·00018	+·00005	+·00021	+·00013	+·00009	·00000	+·00001
17	−·00005	−·00005	+·00002	−·00005	−·00002	+·00024	·00000	+·00020	+·00008	+·00009	·00000	−·00004
18	−·00005	·00000	+·00011	−·00012	+·00008	+·00027	−·00010	+·00008	+·00004	+·00002	·00000	+·00001
19	−·00005	+·00008	+·00010	−·00017	+·00007	+·00010	−·00003	+·00009	−·00004	+·00001	+·00001	+·00003
20	+·00004	+·00001	+·00024	−·00015	+·00012	−·00006	−·00005	+·00002	−·00005	+·00007	+·00001	+·00005
21	−·00006	+·00004	+·00014	−·00005	+·00011	−·00008	+·00001	+·00002	−·00004	+·00006	+·00005	+·00004
22	+·00008	+·00001	+·00007	+·00006	−·00004	−·00006	+·00003	+·00007	−·00005	+·00009	·00000	+·00008
23	+·00011	−·00009	−·00008	+·00011	·00000	+·00001	+·00006	−·00001	−·00002	·00000	−·00007	+·00007
Coefficients. A_1	−·00001	+·00003	+·00003	−·00002	−·00004	−·00003	−·00004	−·00007	−·00001	+·00005	·00000	−·00009
B_1	+·00005	+·00003	+·00006	−·00003	+·00004	+·00008	+·00001	+·00004	+·00001	+·00008	−·00002	−·00002
A_2	−·00012	−·00001	+·00010	−·00009	−·00001	+·00007	−·00003	+·00012	+·00005	−·00001	+·00007	+·00007
B_2	+·00001	−·00001	+·00005	−·00004	+·00002	−·00008	−·00006	−·00003	−·00007	+·00004	−·00001	·00000
A_3	−·00004	+·00004	+·00007	−·00002	+·00001	−·00005	−·00003	−·00006	−·00004	−·00001	·00000	−·00003
B_3	−·00002	+·00001	+·00005	+·00003	−·00001	−·00004	+·00002	+·00002	+·00002	+·00003	+·00006	+·00004
Number of lunar days' observations in abstract	51	340	87	341	80	55	87	59	347	55	349	92

COLABA OBSERVATORY.

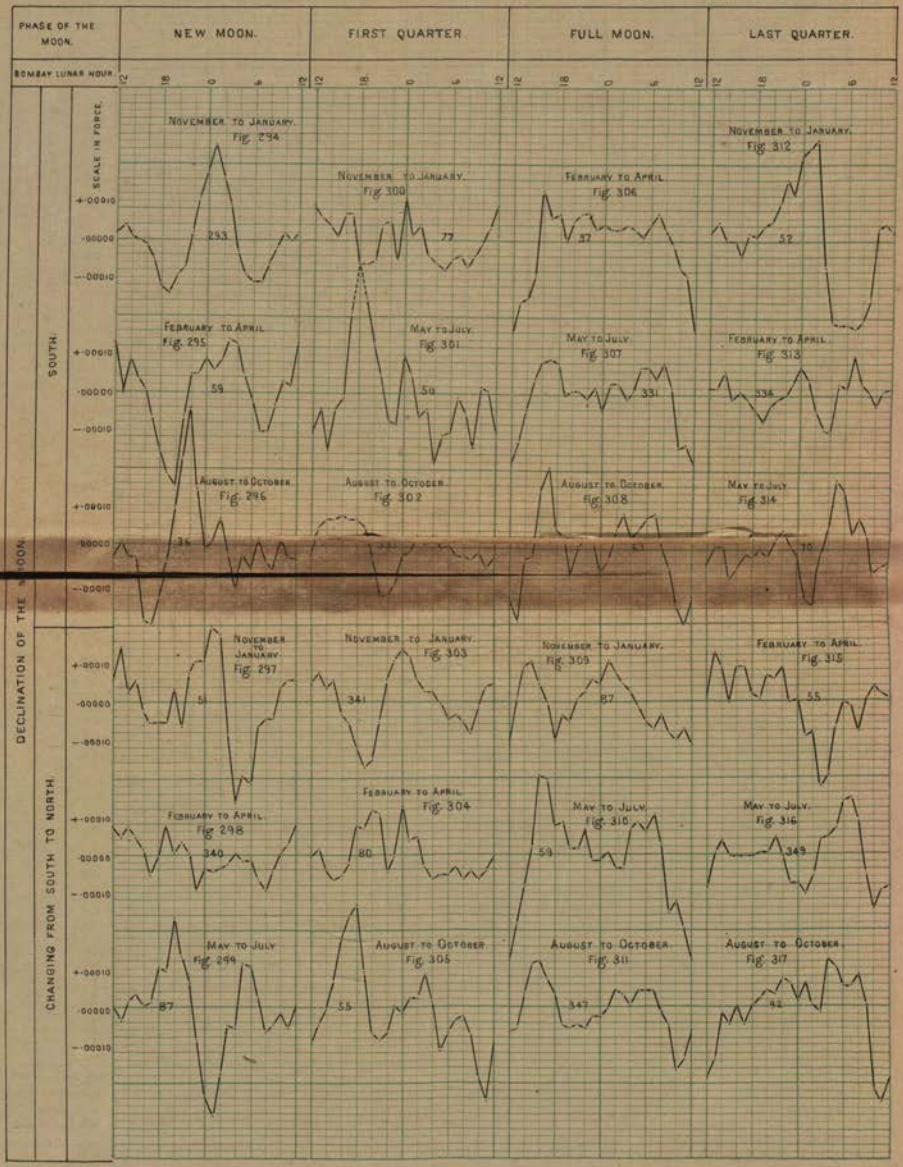
LUNAR DIURNAL VARIATION OF DECLINATION.

Plate XVII.


PHASE OF THE MOON
NEW MOON.
FIRST QUARTER.
FULL MOON.
LAST QUARTER.
SOLAR LUNAR HOUR.
DECLINATION OF THE MOON.
NORTH.
CHANGING FROM NORTH TO SOUTH.
SCALE IN FORCE.
FEBRUARY TO APRIL. Fig. 270. 38
NOVEMBER TO JANUARY. Fig. 276. 42
NOVEMBER TO JANUARY. Fig. 282. 302
NOVEMBER TO JANUARY. Fig. 288. 70
MAY TO JULY. Fig. 271. 323
FEBRUARY TO APRIL. Fig. 277. 329
FEBRUARY TO APRIL. Fig. 283. 56
MAY TO JULY. Fig. 289. 41
AUGUST TO OCTOBER. Fig. 272. 70
MAY TO JULY. Fig. 278. 81
AUGUST TO OCTOBER. Fig. 284. 34
AUGUST TO OCTOBER. Fig. 290. 124
NOVEMBER TO JANUARY. Fig. 273. 79
FEBRUARY TO APRIL. Fig. 279. 34
NOVEMBER TO JANUARY. Fig. 285. 57
NOVEMBER TO JANUARY. Fig. 291. 335
MAY TO JULY. Fig. 274. 52
MAY TO JULY. Fig. 280. 365
FEBRUARY TO APRIL. Fig. 286. 322
FEBRUARY TO APRIL. Fig. 292. 74
AUGUST TO OCTOBER. Fig. 275. 343
AUGUST TO OCTOBER. Fig. 281. 90
MAY TO JULY. Fig. 287. 74
AUGUST TO OCTOBER. Fig. 293. 44

B 825

THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.



THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.

The last six numbers but one in the several columns of Tables 60 to 63 show the values of the coefficients, derived from the respective sets of hourly excesses, in the series

$$\delta_\theta = A_1 \cos\theta + B_1 \sin\theta + A_2 \cos 2\theta + B_2 \sin 2\theta + \&c.$$

in which θ represents the hour angle and δ_θ the excess for the corresponding hour.

Curves have been constructed, in the usual manner, to represent these variations, and appear as Figs. 270 to 317 on Plate XVII.

165. By means of the sums and numbers of days marked at the feet of the lunar abstracts combinations were also made first irrespective of the moon's declination, and then irrespective of the phases of the moon. The results—the mean excesses for all the days for which entries of lunar differences are found—are shown in Tables 64 to 67.

TABLE 64.

PHASE OF MOON.	NEW.							FIRST QUARTER.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0	+·00015	−·00003	−·00021	−·00016	−·00020	+·00008	−·00007	+·00013	+·00006	−·00007	−·00006	−·00007	+·00009	+·00001
1	+·00020	−·00004	−·00019	−·00009	−·00016	+·00011	−·00003	+·00009	+·00005	−·00002	−·00003	−·00002	+·00006	+·00002
2	+·00016	−·00003	−·00009	+·00001	−·00005	+·00007	+·00001	+·00004	+·00005	+·00001	+·00003	+·00003	+·00004	+·00003
3	+·00007	·00000	+·00002	+·00008	+·00005	+·00003	+·00004	+·00002	·00000	+·00001	+·00004	+·00003	+·00001	+·00002
4	−·00005	+·00002	+·00002	+·00013	+·00008	−·00002	+·00003	+·00001	−·00002	−·00002	+·00003	·00000	−·00001	·00000
5	−·00010	·00000	+·00013	+·00010	+·00013	−·00006	+·00004	−·00002	−·00006	·00000	−·00001	·00000	−·00005	−·00003
6	−·00013	−·00001	+·00008	+·00004	+·00007	−·00008	·00000	−·00005	−·00005	−·00002	−·00001	−·00002	−·00005	−·00003
7	−·00013	−·00006	+·00004	−·00001	+·00002	−·00010	−·00004	−·00003	−·00006	−·00002	−·00002	−·00003	−·00004	−·00003
8	−·00007	−·00008	+·00001	−·00001	−·00001	−·00007	−·00003	−·00005	−·00005	−·00004	−·00002	−·00004	−·00004	−·00004
9	−·00002	−·00003	+·00001	−·00002	−·00001	−·00002	−·00002	−·00007	−·00003	−·00005	−·00002	−·00004	−·00005	−·00004
10	+·00002	+·00002	+·00002	+·00002	+·00002	+·00002	+·00002	−·00002	·00000	−·00004	−·00005	−·00004	−·00001	−·00003
11	+·00001	+·00004	+·00002	·00000	+·00001	+·00002	+·00002	+·00003	+·00005	−·00008	−·00008	−·00007	+·00003	−·00002
12	+·00002	+·00009	+·00001	·00000	+·00002	+·00005	+·00003	+·00007	+·00005	−·00011	−·00004	−·00008	+·00006	−·00001
13	+·00005	+·00006	−·00001	−·00001	·00000	+·00005	+·00002	+·00008	+·00001	−·00010	+·00001	−·00007	+·00007	·00000
14	+·00002	+·00008	·00000	+·00001	·00000	+·00005	+·00003	+·00006	+·00002	−·00008	+·00005	−·00003	+·00005	+·00001
15	+·00002	+·00005	+·00001	+·00002	+·00001	+·00003	+·00002	+·00007	−·00003	+·00003	+·00010	+·00004	+·00004	+·00004
16	−·00001	+·00001	+·00002	+·00005	+·00004	·00000	+·00002	−·00001	−·00001	+·00015	+·00014	+·00013	+·00001	+·00007
17	−·00004	−·00005	+·00006	+·00005	+·00005	−·00004	+·00001	−·00002	−·00001	+·00018	+·00011	+·00014	·00000	+·00007
18	−·00009	−·00002	+·00012	+·00003	+·00008	−·00006	+·00001	−·00011	−·00002	+·00018	+·00010	+·00013	−·00005	+·00004
19	−·00010	+·00004	+·00012	+·00006	+·00011	−·00006	+·00003	−·00017	−·00001	+·00017	+·00006	+·00012	−·00009	+·00001
20	−·00004	−·00002	+·00008	+·00002	+·00007	−·00006	+·00001	−·00014	·00000	+·00013	−·00004	+·00007	−·00009	−·00001
21	−·00005	+·00002	−·00003	−·00006	−·00004	−·00003	−·00003	−·00004	+·00005	−·00001	−·00011	−·00003	−·00003	−·00003
22	+·00002	+·00001	−·00009	−·00012	−·00011	+·00002	−·00004	+·00006	−·00001	−·00006	−·00011	−·00008	+·00001	−·00003
23	+·00009	−·00007	−·00015	−·00016	−·00019	+·00004	−·00008	+·00007	+·00002	−·00008	−·00009	−·00008	+·00004	−·00002
Number of lunar days' observations in abstract ...	423	437	460	449	919	850	1769	460	463	476	482	946	935	1881

Table 65.

Phase of Moon.	Full.							Last Quarter.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0	+·00006	−·00001	−·00003	−·00002	−·00003	+·00003	·00000	+·00009	+·00007	−·00007	−·00006	−·00005	+·00006	+·00001
1	+·00004	·00000	+·00002	+·00001	+·00001	+·00003	+·00001	+·00011	+·00004	−·00011	−·00004	−·00008	+·00008	·00000
2	+·00004	−·00003	+·00002	+·00006	+·00002	+·00002	+·00002	+·00011	−·00002	−·00005	−·00001	−·00006	+·00007	+·00001
3	·00000	−·00005	−·00001	+·00005	+·00001	−·00001	·00000	+·00009	−·00010	+·00003	+·00002	·00000	+·00002	+·00001
4	−·00003	−·00008	+·00001	+·00002	·00000	−·00004	−·00002	+·00001	−·00011	+·00006	+·00013	+·00006	−·00002	+·00002
5	−·00008	−·00008	+·00006	+·00004	+·00003	−·00006	−·00001	−·00006	−·00002	+·00010	+·00017	+·00013	−·00004	+·00004
6	−·00013	−·00007	+·00006	+·00005	+·00004	−·00009	−·00003	−·00012	+·00001	+·00014	+·00012	+·00013	−·00006	+·00004
7	−·00013	+·00001	+·00006	+·00004	+·00006	−·00008	+·00005	−·00016	+·00007	+·00012	+·00005	+·00010	−·00006	+·00002
8	−·00016	+·00008	+·00007	−·00002	+·00004	−·00006	−·00001	−·00016	−·00001	+·00009	−·00001	+·00004	−·00008	−·00002
9	−·00012	+·00008	−·00001	−·00006	−·00001	−·00005	−·00003	−·00012	·00000	−·00004	−·00007	−·00004	−·00008	−·00006
10	−·00005	+·00008	−·00013	−·00016	−·00012	−·00001	−·00007	−·00003	−·00001	−·00015	−·00011	−·00013	−·00002	−·00007
11	+·00005	+·00004	−·00013	−·00012	−·00012	+·00004	−·00004	+·00007	+·00002	−·00010	−·00009	−·00009	+·00004	−·00002
12	+·00012	+·00001	−·00019	−·00006	−·00013	+·00007	−·00003	+·00005	+·00003	−·00008	−·00005	−·00006	+·00004	−·00001
13	+·00016	−·00005	−·00014	−·00008	−·00011	+·00006	−·00003	+·00007	+·00003	+·00001	·00000	+·00001	+·00005	+·00003
14	+·00015	−·00004	−·00005	+·00003	−·00002	+·00007	+·00002	+·00002	+·00005	+·00004	+·00002	+·00003	+·00004	+·00003
15	+·00011	−·00003	+·00004	+·00009	+·00005	+·00006	+·00005	+·00001	·00000	−·00001	+·00002	−·00001	+·00001	·00000
16	·00000	·00000	+·00012	+·00012	+·00012	+·00001	+·00006	−·00002	+·00002	·00000	+·00002	+·00001	·00000	·00000
17	−·00007	+·00003	+·00013	+·00009	+·00011	−·00002	+·00004	·00000	·00000	·00000	−·00001	·00000	·00000	·00000
18	−·00004	+·00001	+·00010	+·00005	+·00007	−·00001	+·00003	−·00002	−·00003	·00000	+·00001	·00000	−·00002	−·00001
19	−·00003	+·00001	+·00002	−·00002	·00000	−·00001	−·00001	−·00002	−·00006	+·00001	−·00004	−·00001	−·00004	−·00003
20	·00000	+·00002	·00000	−·00004	−·00001	·00000	−·00001	−·00002	−·00002	·00000	+·00001	+·00001	−·00002	−·00001
21	+·00003	+·00003	·00000	−·00003	·00000	+·00002	+·00001	+·00003	·00000	+·00005	−·00002	+·00004	−·00001	+·00001
22	+·00003	+·00001	·00000	−·00003	−·00001	+·00001	·00000	+·00003	+·00001	·00000	−·00002	·00000	+·00001	+·00001
23	+·00003	+·00003	+·00001	−·00001	+·00002	+·00001	+·00001	+·00005	+·00003	−·00006	−·00006	−·00004	+·00003	−·00001
Number of lunar days' observations in abstract ...	446	417	464	444	897	874	1771	457	463	460	460	921	919	1840

Table 66.

Declination of Moon.	North.							Changing from North to South.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0	+·00008	+·00002	−·00017	−·00007	−·00014	+·00007	−·00003	+·00006	·00000	−·00010	−·00018	−·00013	+·00003	−·00005
1	+·00004	+·00004	−·00013	−·00003	−·00009	+·00005	−·00002	+·00008	+·00001	−·00006	−·00012	−·00008	+·00004	−·00002
2	+·00005	+·00003	−·00005	·00000	−·00003	+·00004	+·00001	+·00006	−·00001	+·00001	·00000	+·00001	+·00004	+·00002
3	+·00003	·00000	+·00005	+·00006	+·00007	·00000	+·00003	+·00008	−·00005	+·00001	+·00008	+·00004	+·00002	+·00003
4	+·00001	−·00002	+·00005	+·00015	+·00010	·00000	+·00005	−·00001	−·00010	−·00001	+·00009	+·00002	−·00003	−·00001
5	−·00004	−·00005	+·00013	+·00018	+·00015	−·00004	+·00005	−·00010	−·00012	·00000	+·00008	+·00002	−·00009	−·00003
6	−·00013	−·00004	+·00009	+·00012	+·00010	−·00008	+·00001	−·00014	−·00008	−·00002	+·00003	−·00001	−·00010	−·00005
7	−·00014	−·00005	+·00004	+·00003	+·00002	−·00009	−·00003	−·00015	·00000	−·00001	−·00001	·00000	−·00009	−·00004
8	−·00017	−·00003	+·00002	−·00005	−·00002	−·00009	−·00005	−·00014	+·00005	−·00001	−·00001	·00000	−·00006	−·00003
9	−·00015	−·00002	−·00002	−·00012	−·00005	−·00010	−·00008	−·00007	+·00007	−·00002	·00000	·00000	−·00002	−·00001
10	−·00008	+·00001	−·00002	−·00009	−·00005	−·00004	−·00004	·00000	+·00009	−·00004	+·00001	·00000	+·00003	+·00001
11	+·00005	+·00006	−·00002	−·00004	−·00003	+·00005	+·00001	+·00008	+·00007	−·00006	−·00001	−·00003	+·00007	+·00002
12	+·00014	+·00007	−·00002	−·00001	−·00002	+·00011	+·00004	+·00007	+·00004	−·00010	−·00001	−·00005	+·00005	·00000
13	+·00017	+·00004	−·00001	+·00001	−·00001	+·00011	+·00005	+·00007	−·00004	−·00011	−·00001	−·00007	+·00003	−·00002
14	+·00016	+·00003	−·00001	+·00001	−·00002	+·00012	+·00005	+·00004	−·00003	−·00007	+·00003	−·00003	+·00002	−·00001
15	+·00013	·00000	−·00001	·00000	−·00002	+·00007	+·00003	+·00001	−·00002	+·00007	+·00008	+·00006	+·00002	+·00004
16	+·00001	−·00001	+·00002	+·00001	+·00002	·00000	+·00001	−·00002	·00000	+·00018	+·00012	+·00014	·00000	+·00007
17	−·00006	−·00001	+·00008	·00000	+·00004	−·00003	+·00001	−·00002	+·00002	+·00018	+·00010	+·00014	·00000	+·00007
18	−·00003	−·00007	+·00012	+·00003	+·00007	−·00004	+·00001	−·00002	+·00002	+·00017	+·00004	+·00012	−·00001	+·00005
19	−·00006	−·00001	+·00011	−·00001	+·00007	−·00006	·00000	−·00001	·00000	+·00014	+·00005	+·00010	−·00001	+·00004
20	−·00002	−·00003	+·00005	+·00002	+·00005	−·00004	·00000	−·00001	+·00001	+·00008	−·00002	+·00004	−·00001	+·00002
21	·00000	+·00003	−·00005	−·00002	−·00001	−·00001	−·00001	+·00004	+·00003	−·00004	−·00009	−·00005	+·00002	−·00001
22	+·00001	·00000	−·00010	−·00007	−·00008	+·00001	−·00004	+·00003	·00000	−·00008	−·00013	−·00011	+·00002	−·00004
23	+·00003	+·00001	−·00014	−·00011	−·00013	+·00002	−·00005	+·00004	+·00003	−·00010	−·00015	−·00011	+·00003	−·00004
Number of lunar days' observations in abstract...	414	425	425	428	852	840	1692	471	450	489	477	973	914	1887

825—32 ap

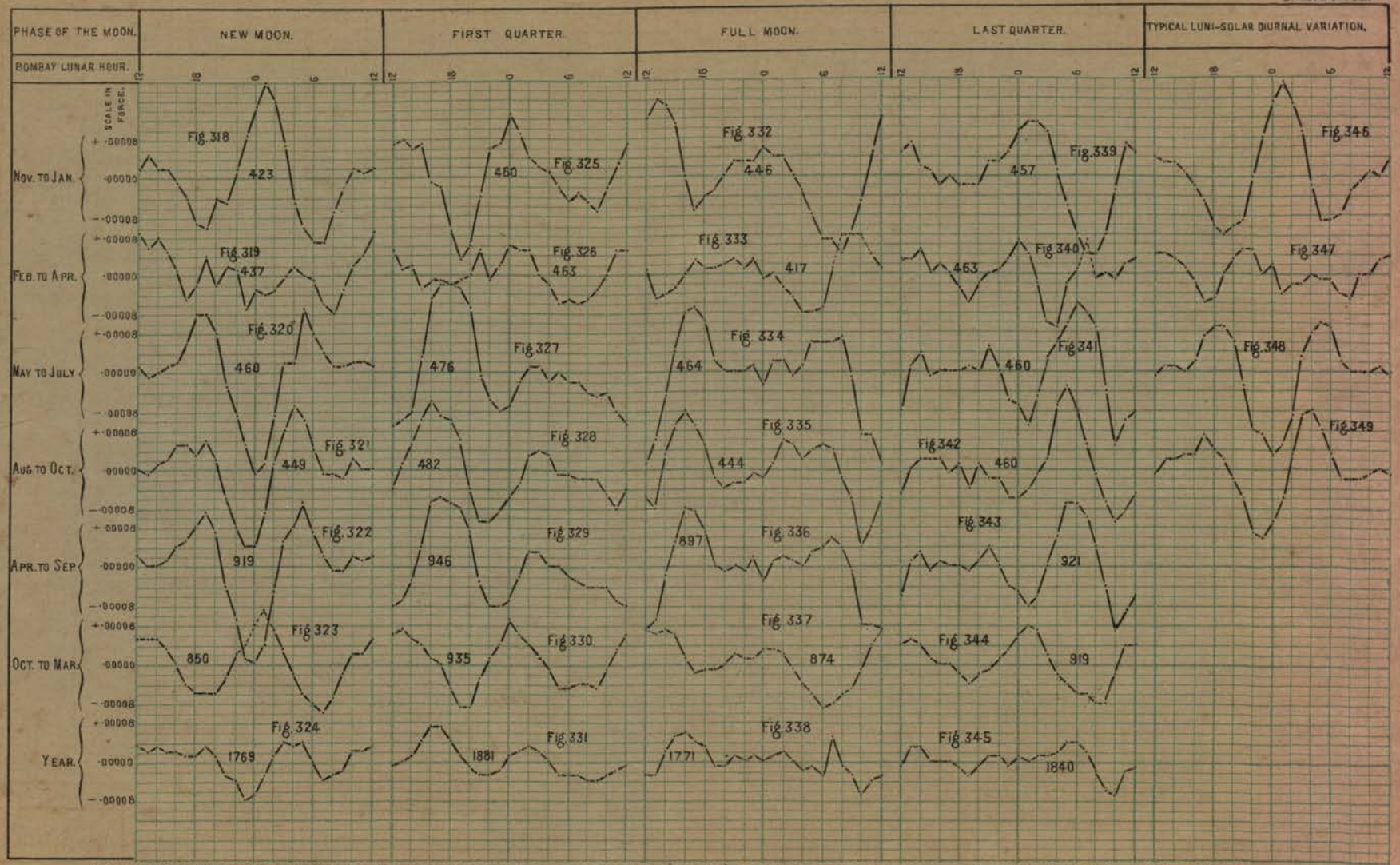
Table 67.

Declination of Moon.	South.							Changing from South to North.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October	April to September.	October to March.	Year.
0 ...	+ ·00017	+ ·00007	− ·00002	− ·00002	− ·00001	+ ·00011	+ ·00005	+ ·00012	·00000	− ·00009	− ·00001	− ·00006	+ ·00007	·00000
1 ...	+ ·00020	+ ·00004	+ ·00001	− ·00001	·00000	+ ·00011	+ ·00006	+ ·00012	− ·00003	− ·00012	+ ·00001	− ·00007	+ ·00007	·00000
2 ..	+ ·00014	− ·00002	− ·00001	+ ·00004	− ·00001	+ ·00008	+ ·00004	+ ·00007	− ·00003	− ·00007	+ ·00004	− ·00003	+ ·00005	+ ·00001
3 ...	+ ·00005	− ·00005	− ·00002	+ ·00002	− ·00001	+ ·00002	·00000	+ ·00002	− ·00005	+ ·00001	+ ·00004	·00000	+ ·00001	+ ·00001
4 ...	− ·00006	− ·00005	·00000	+ ·00002	·00000	− ·00004	− ·00002	·00000	− ·00003	+ ·00003	+ ·00004	+ ·00003	− ·00001	+ ·00001
5 ...	− ·00010	+ ·00003	+ ·00007	·00000	+ ·00005	− ·00005	·00000	− ·00002	− ·00002	+ ·00008	+ ·00004	+ ·00007	− ·00003	+ ·00002
6 ...	− ·00011	+ ·00002	+ ·00006	+ ·00001	+ ·00005	− ·00006	·00000	− ·00007	− ·00002	+ ·00013	+ ·00004	+ ·00008	− ·00004	+ ·00002
7 ...	− ·00011	+ ·00007	+ ·00004	·00000	+ ·00005	− ·00005	·00000	− ·00004	− ·00005	+ ·00012	+ ·00004	+ ·00008	− ·00004	+ ·00002
8 ...	− ·00008	+ ·00003	+ ·00006	− ·00001	+ ·00004	− ·00005	− ·00001	− ·00005	− ·00009	+ ·00005	+ ·00001	+ ·00001	− ·00004	− ·00002
9 ...	− ·00004	·00000	·00000	− ·00004	·00000	− ·00004	− ·00002	− ·00007	− ·00003	− ·00006	− ·00003	− ·00005	− ·00005	− ·00005
10 ...	+ ·00001	− ·00003	− ·00011	− ·00003	− ·00009	+ ·00001	− ·00004	− ·00002	+ ·00001	− ·00011	− ·00017	− ·00013	− ·00003	− ·00007
11 ...	+ ·00001	·00000	− ·00010	− ·00007	− ·00010	+ ·00002	− ·00004	+ ·00002	+ ·00002	− ·00010	− ·00016	− ·00010	·00000	− ·00005
12 ...	+ ·00003	+ ·00001	− ·00015	− ·00004	− ·00011	+ ·00004	− ·00004	+ ·00002	+ ·00006	− ·00009	− ·00009	− ·00007	+ ·00003	− ·00002
13 ...	+ ·00005	·00000	− ·00009	+ ·00001	− ·00006	+ ·00004	− ·00001	+ ·00007	+ ·00006	− ·00002	− ·00007	− ·00003	+ ·00005	+ ·00001
14 ...	+ ·00002	+ ·00005	− ·00004	+ ·00005	·00000	+ ·00004	+ ·00002	+ ·00005	+ ·00006	+ ·00002	+ ·00002	+ ·00004	+ ·00004	+ ·00004
15	·00000	− ·00001	+ ·00001	+ ·00005	+ ·00002	+ ·00001	+ ·00001	+ ·00007	+ ·00003	+ ·00001	+ ·00009	+ ·00004	+ ·00005	+ ·00005
16 ..	·00000	+ ·00002	+ ·00005	+ ·00006	+ ·00007	·00000	+ ·00003	− ·00002	+ ·00002	+ ·00003	+ ·00012	+ ·00006	+ ·00001	+ ·00004
17 ...	− ·00002	− ·00001	+ ·00009	+ ·00007	+ ·00008	− ·00001	+ ·00003	− ·00004	− ·00003	+ ·00003	+ ·00007	+ ·00003	− ·00001	+ ·00001
18 ...	− ·00009	− ·00005	+ ·00009	+ ·00005	+ ·00007	− ·00007	·00000	− ·00011	+ ·00001	+ ·00003	+ ·00006	+ ·00003	− ·00003	·00000
19 ...	− ·00010	− ·00009	+ ·00003	+ ·00004	+ ·00002	− ·00008	− ·00003	− ·00013	+ ·00007	+ ·00004	− ·00001	+ ·00003	− ·00005	− ·00001
20 ...	− ·00006	− ·00005	+ ·00001	− ·00002	− ·00001	− ·00005	− ·00003	− ·00012	+ ·00004	+ ·00005	− ·00003	+ ·00004	− ·00007	− ·00001
21	− ·00003	− ·00001	+ ·00002	− ·00007	− ·00001	− ·00003	− ·00002	− ·00004	+ ·00005	+ ·00006	− ·00003	+ ·00004	− ·00002	+ ·00001
22 ..	+ ·00004	+ ·00001	·00000	− ·00006	− ·00002	+ ·00002	·00000	+ ·00006	+ ·00001	+ ·00002	− ·00002	+ ·00002	+ ·00001	+ ·00001
23 ..	+ ·00008	+ ·00003	+ ·00001	− ·00005	− ·00001	+ ·00004	+ ·00002	+ ·00010	− ·00006	− ·00006	·00000	− ·00004	+ ·00003	− ·00001
Number of lunar days' observations in abstract.	422	430	451	436	877	862	1739	479	475	495	494	981	962	1943

COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF DECLINATION.

Plate XVIII.



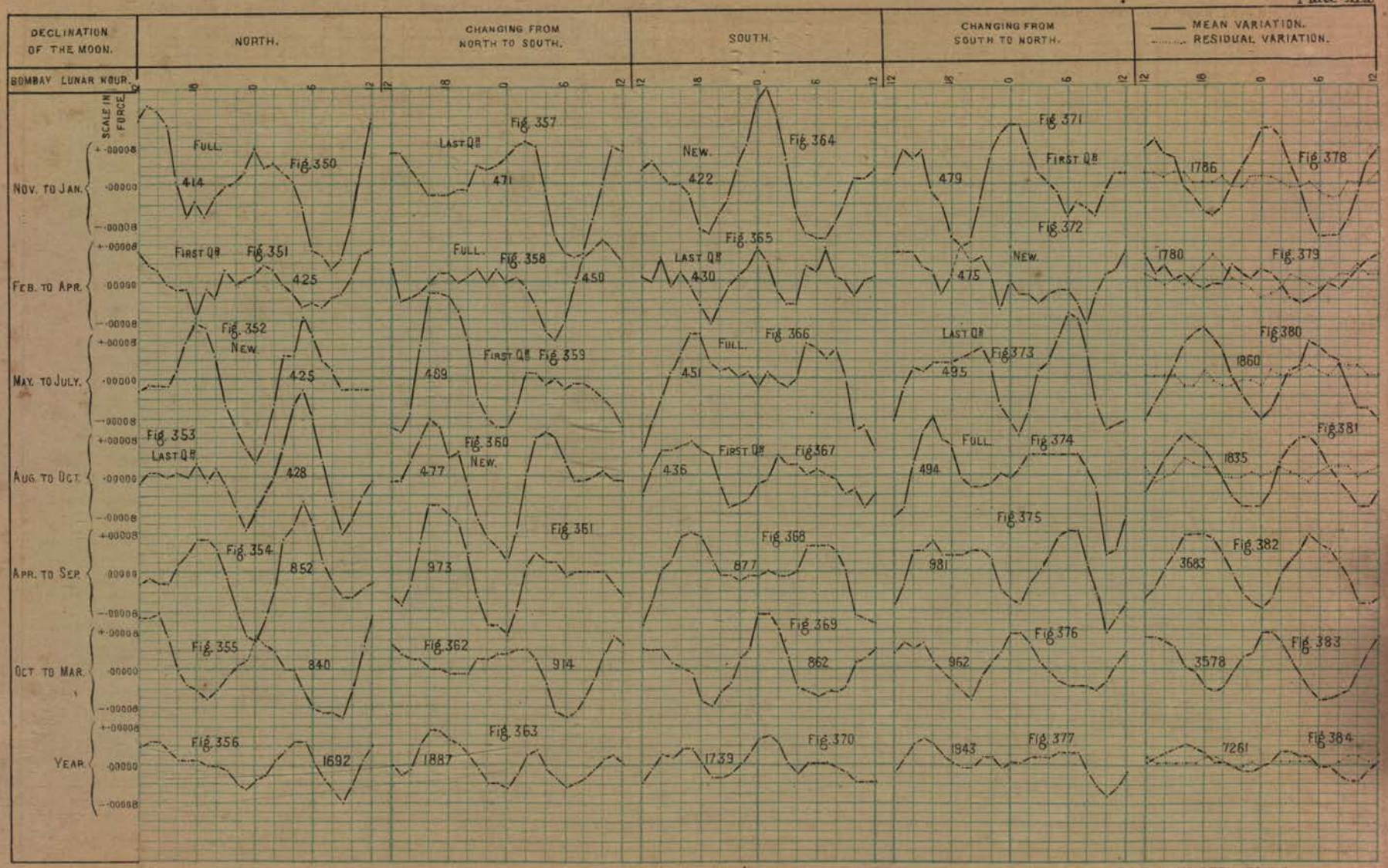
THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.

B 825

COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF DECLINATION.

Plate XIX



THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.

B 825

166. The curves that have been constructed to represent the variations otherwise expressed by the hourly excesses for the several quarters and phases are Figs. 318 to 345, and for the several quarters and declinations of the moon Figs. 350 to 377. The latter figures are marked with the phases to which they principally correspond, and it will be noticed that, comparing like phases for each quarter on the two sets of figures, the curves are nearly identical throughout: they are also nearly identical with the curves that correspond at once to the same phase and declination in each quarter on Plate XVII; but as the variations represented by the latter are of a purer type—being unmixed with the variations of adjacent declinations or phases—they are generally slightly larger in range and, perhaps, of more pronounced though similar character.

167. Considering now the phase curves (Figs. 318 to 345) by themselves, we are led to form the hypothesis that the bulk of the phenomenon that we are dealing with is really no lunar diurnal variation at all, but a solar diurnal variation that depends on the relative positions of the sun and moon,—a variation that is of the same character at new and full moon and of the same character at first and last quarters, but of reverse character at new or full moon as compared with that of first or last quarter. It will presently be seen that though the typical variation of one quarter differs from that of another, this hypothesis holds good in each quarter of the year separately, and that it reduces the unexplained residual phenomenon to a small fraction of the observed variations that seek for a theoretical explanation.

168. As the lunar day roughly approximates to the same length as the solar day, we suppose the observed lunar diurnal variation at new moon to imply with rough approximation a solar diurnal variation of the same character; and we enter the hourly excesses in a table having solar hours, from 0 to 23, marked at the top of the columns: under these numbers we enter the excesses of full moon, placing the number belonging to the 0th hour of lunar time under the 12th hour of solar time, and we then take the sums of the two sets of numbers: again, we enter the excesses of first quarter, placing the number belonging to the 0th hour of lunar time under the 6th hour of solar time; and under these we enter the excesses of last quarter placing the number of the 0th hour of lunar time under the 18th hour of solar time, and we then take the sum of these two sets of numbers: next, we subtract the latter sums from the former and divide the results by 4, calling the series of quotients the typical luni-solar variation. In this way have been obtained the typical variations shown in Table 68, using as data the numbers in columns 2, 5, 7 and 12 of Table 60; 3, 5, 8 and 10 of Table 61; 1, 6, 8 and 11 of Table 62; and 2, 4, 9 and 11 of Table 63.

TABLE 68.

Bombay Astronomical Hour.	0	1	2	3	4	5	6	7	8	9	10	11
Nov. to Jan.	+ ·00015	+ ·00019	+ ·00015	+ ·00009	− ·00002	− ·00009	− ·00009	− ·00008	− ·00003	− ·00001	+ ·00001	·00000
Feb to April.	+ ·00002	− ·00004	− ·00002	− ·00002	·00000	− ·00001	− ·00001	− ·00004	− ·00005	·00000	·00000	+ ·00003
May to July.	− ·00017	− ·00015	− ·00009	+ ·00003	+ ·00008	+ ·00010	+ ·00009	+ ·00002	·00000	·00000	·00000	+ ·00001
Aug. to Oct.	− ·00011	− ·00006	+ ·00003	+ ·00011	+ ·00012	+ ·00008	+ ·00003	− ·00002	− ·00002	− ·00002	− ·00001	·00000

Bombay Astronomical Hour.	12	13	14	15	16	17	18	19	20	21	22	23
Nov. to Jan.	+ ·00004	+ ·00003	+ ·00003	+ ·00001	− ·00002	− ·00005	− ·00010	− ·00012	− ·00010	− ·00009	·00000	+ ·00008
Feb. to April.	+ ·00004	+ ·00004	+ ·00003	+ ·00001	− ·00002	− ·00006	− ·00005	·00000	+ ·00003	+ ·00005	+ ·00005	·00000
May to July.	− ·00001	+ ·00001	+ ·00001	·00000	+ ·00002	+ ·00007	+ ·00009	+ ·00009	+ ·00006	− ·00003	− ·00012	− ·00013
Aug. to Oct.	− ·00001	+ ·00002	+ ·00002	+ ·00003	+ ·00003	+ ·00007	+ ·00004	+ ·00002	− ·00002	− ·00006	− ·00013	− ·00014

These variations are curved in Figs. 346 to 349.

169. And now, eliminating, by a sort of reversal of the process described above, the typical from the observed variations, and then taking the means of the residual quantities, properly arranged, as if these were proper lunar variations, we obtain the following numbers, which are curved, in dotted lines, in Figs. 378 to 381 and 384.

TABLE 69.

Bombay Astronomical Hour.	0	1	2	3	4	5	6	7	8	9	10	11
Nov. to Jan.	+ ·00001	+ ·00001	·00000	− ·00001	− ·00001	·00000	− ·00002	− ·00003	− ·00003	·00000	·00000	·00000
Feb. to April.	− ·00004	− ·00003	− ·00002	+ ·00001	·00000	− ·00001	− ·00002	− ·00001	+ ·00001	+ ·00001	+ ·00003	+ ·00001
May to July.	− ·00002	+ ·00001	·00000	·00000	+ ·00001	+ ·00002	+ ·00001	·00000	+ ·00002	+ ·00002	+ ·00002	·00000
Aug. to Oct.	− ·00001	·00000	+ ·00001	·00000	− ·00001	− ·00002	·00000	+ ·00001	+ ·00001	+ ·00001	− ·00001	·00000
Year ...	− ·00001	·00000	·00000	·00000	·00000	·00000	− ·00001	− ·00001	·00000	+ ·00001	+ ·00001	·00000

Bombay Astronomical Hour.	12	13	14	15	16	17	18	19	20	21	22	23
Nov. to Jan.	+ ·00002	+ ·00002	+ ·00001	+ ·00002	+ ·00002	·00000	·00000	·00000	+ ·00001	− ·00001	− ·00001	+ ·00001
Feb. to April	+ ·00001	·00000	− ·00001	·00000	− ·00001	+ ·00001	+ ·00003	+ ·00005	+ ·00003	·00000	− ·00001	− ·00002
May to July.	·00000	·00000	·00000	·00000	− ·00002	− ·00002	+ ·00001	− ·00001	− ·00002	− ·00002	− ·00001	− ·00001
Aug. to Oct.	+ ·00001	− ·00002	− ·00001	·00000	+ ·00003	+ ·00002	+ ·00001	+ ·00001	− ·00001	− ·00001	− ·00001	·00000
Year ...	+ ·00001	·00000	·00000	·00000	·00000	·00000	+ ·00001	+ ·00001	·00000	− ·00001	− ·00001	·00000

169*a*. If, however, the hypothesis of paragraph 167 were true and the period involved was the solar day and not the lunar day, we should expect that our process of finding the typical variation would have resulted in the contraction of the range of the actual luni-solar variation, because in combining three or four lunar days before and after each phase with the exact day of that phase, the maximum and minimum events, instead of being exactly superimposed as they would have been if the observations had been classified in solar days, would have been spread over some five or six consecutive solar hours, and consequently the mean maximum and mean minimum results would be of more nearly equal magnitude than those of the actual variation. Hence, if the investigation were repeated, arranging the lunar abstracts in solar instead of lunar days, but making no other change* in the process of reduction, we might find a criterion for attributing the variation rather to the one period than to the other. Such repetition has been made for each quarter of the year and each phase of the moon, using the identical lunar differences for the years 1846 to 1870, that formed the basis of the preceding investigation. The results obtained are shown in Tables 69*g* to 69*c* and they are curved to correspond with the curves of Plate XVIII, in Figs 384*a* to 384*ff* of Plate XIX*a*.

* Except that, there being one more solar day in a lunation than the number of lunar days, the days after new moon were distributed as follows, viz., 5th to 11th under first quarter; 12th to 19th under full moon; 20th to 26th under last quarter; and the remainder under new moon.

COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF DECLINATION.

VARIATIONS FOUND ON THE SUPPOSITION THAT THE PERIOD IS THE SOLAR DAY AND NOT THE LUNAR DAY.

Plate XIX*a*.

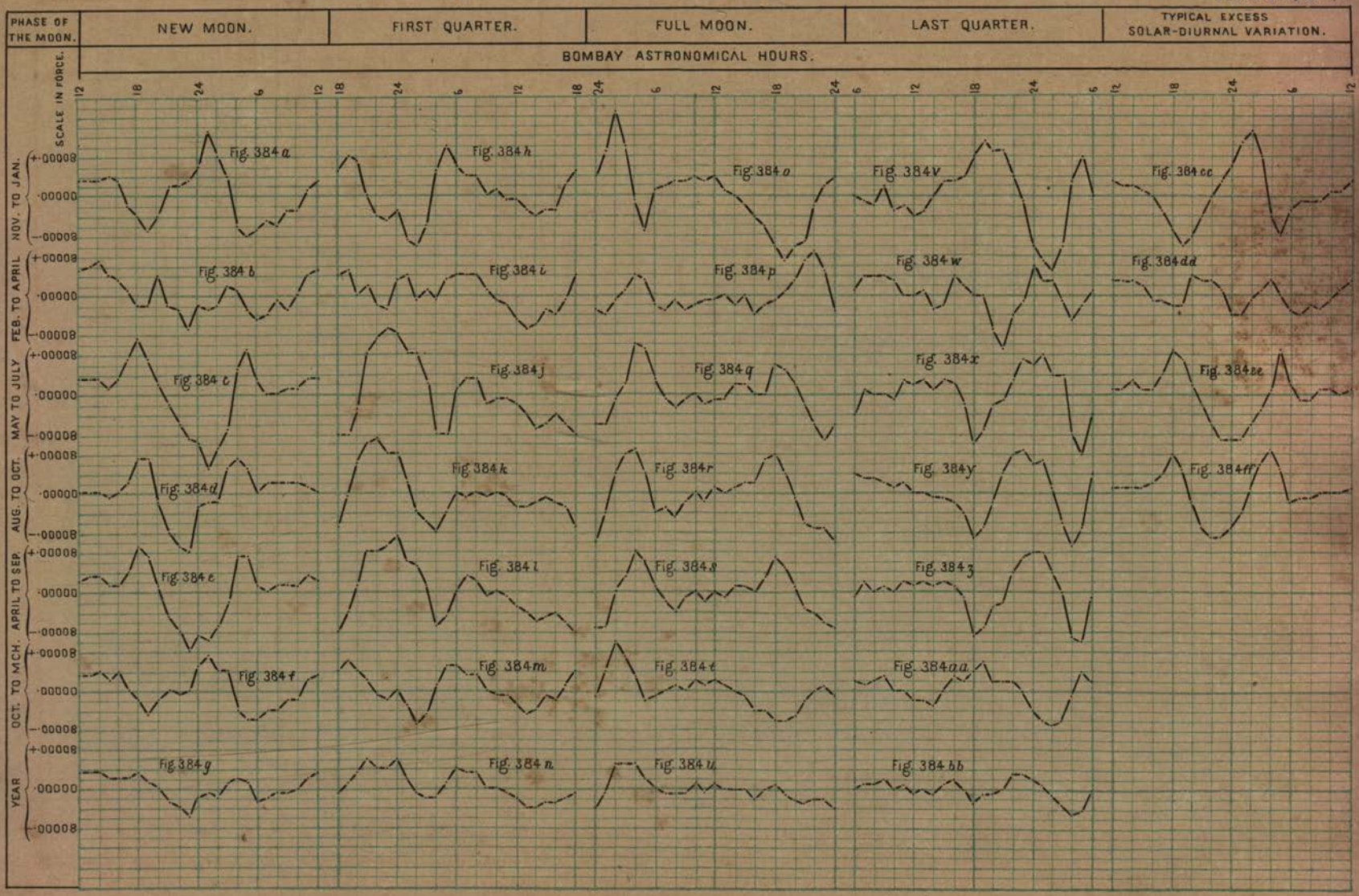


Table 69*a*.

Phase of Moon.	New.							First Quarter.						
Bombay Astronomical Hours.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
h. m.														
0 12 ...	+ ·00006	− ·00002	− ·00010	− ·00003	− ·00009	+ ·00005	− ·00002	− ·00003	+ ·00003	+ ·00012	+ ·00008	+ ·00011	·00000	+ ·00006
1 12 ...	+ ·00013	− ·00003	− ·00015	− ·00002	− ·00010	+ ·00007	− ·00001	− ·00009	+ ·00004	+ ·00008	+ ·00002	+ ·00006	− ·00003	+ ·00002
2 12 ...	+ ·00008	− ·00002	− ·00011	− ·00002	− ·00007	+ ·00004	− ·00002	− ·00010	− ·00001	+ ·00008	− ·00003	+ ·00005	− ·00007	− ·00001
3 12 ...	+ ·00004	+ ·00002	− ·00007	+ ·00005	− ·00002	+ ·00004	+ ·00001	− ·00006	+ ·00001	+ ·00002	− ·00006	+ ·00001	− ·00005	− ·00002
4 12 ...	− ·00006	+ ·00001	+ ·00005	+ ·00007	+ ·00007	− ·00004	+ ·00002	+ ·00005	− ·00001	− ·00008	− ·00008	− ·00007	+ ·00001	− ·00002
5 12 ...	− ·00008	− ·00003	+ ·00009	+ ·00005	+ ·00007	− ·00006	+ ·00001	+ ·00010	+ ·00003	− ·00008	− ·00004	− ·00005	+ ·00005	+ ·00001
6 12 ...	− ·00007	− ·00005	+ ·00003	·00000	+ ·00001	− ·00006	− ·00003	+ ·00006	+ ·00004	+ ·00001	·00000	·00000	+ ·00005	+ ·00004
7 12 ...	− ·00005	− ·00004	·00000	+ ·00002	·00000	− ·00004	− ·00002	+ ·00004	+ ·00004	+ ·00003	− ·00001	+ ·00003	+ ·00003	+ ·00003
8 12 ...	− ·00006	− ·00001	·00000	+ ·00002	+ ·00001	− ·00004	− ·00001	+ ·00004	+ ·00004	+ ·00003	·00000	+ ·00002	+ ·00003	+ ·00003
9 12 ...	− ·00003	− ·00003	+ ·00001	+ ·00002	+ ·00001	− ·00002	− ·00001	·00000	+ ·00001	− ·00002	− ·00001	− ·00001	·00000	·00000
10 12 ...	− ·00003	·00000	+ ·00001	+ ·00002	+ ·00001	− ·00002	·00000	+ ·00001	− ·00001	− ·00001	·00000	·00000	− ·00001	·00000
11 12 ...	+ ·00001	+ ·00004	+ ·00003	+ ·00001	+ ·00003	+ ·00002	+ ·00002	− ·00001	− ·00002	− ·00001	− ·00001	− ·00001	− ·00001	− ·00001
12 12 ...	+ ·00003	+ ·00005	+ ·00003	·00000	+ ·00002	+ ·00003	+ ·00003	− ·00001	− ·00005	− ·00002	− ·00003	− ·00003	− ·00003	− ·00002
13 12 ...	+ ·00003	+ ·00006	+ ·00003	·00000	+ ·00003	+ ·00003	+ ·00003	− ·00003	− ·00007	− ·00004	− ·00003	− ·00004	− ·00005	− ·00004
14 12 ...	+ ·00003	+ ·00007	+ ·00003	·00000	+ ·00003	+ ·00004	+ ·00003	− ·00004	− ·00006	− ·00007	− ·00002	− ·00006	− ·00004	− ·00004
15 12 ...	+ ·00004	+ ·00004	+ ·00001	− ·00001	+ ·00001	+ ·00002	+ ·00002	− ·00003	− ·00003	− ·00006	− ·00001	− ·00005	− ·00001	− ·00003
16 12 ...	+ ·00003	+ ·00003	+ ·00003	·00000	+ ·00001	+ ·00004	+ ·00002	− ·00003	− ·00004	− ·00004	− ·00002	− ·00004	− ·00002	− ·00003
17 12 ...	− ·00002	+ ·00001	+ ·00007	+ ·00002	+ ·00004	·00000	+ ·00002	+ ·00002	− ·00001	− ·00006	− ·00003	− ·00006	+ ·00001	− ·00002
18 12 ...	− ·00004	− ·00002	+ ·00011	+ ·00007	+ ·00009	− ·00002	+ ·00003	+ ·00005	+ ·00004	− ·00008	− ·00007	− ·00008	+ ·00004	− ·00001
19 12 ...	− ·00007	− ·00002	+ ·00007	+ ·00007	+ ·00007	− ·00005	+ ·00001	+ ·00008	+ ·00005	− ·00008	− ·00001	− ·00004	+ ·00006	+ ·00001
20 12 ...	− ·00004	+ ·00004	+ ·00002	− ·00002	+ ·00001	− ·00002	·00000	+ ·00007	·00000	− ·00003	+ ·00006	+ ·00001	+ ·00004	+ ·00003
21 12 ...	+ ·00002	− ·00002	− ·00002	− ·00008	− ·00005	·00000	− ·00003	·00000	+ ·00002	+ ·00008	+ ·00010	+ ·00008	+ ·00002	+ ·00006
22 12 ...	+ ·00002	− ·00003	− ·00006	− ·00011	− ·00008	− ·00001	− ·00004	− ·00004	− ·00002	+ ·00011	+ ·00011	+ ·00008	− ·00001	+ ·00004
23 12 ...	+ ·00003	− ·00007	− ·00009	− ·00012	− ·00012	·00000	− ·00006	− ·00005	− ·00003	+ ·00013	+ ·00008	+ ·00009	− ·00002	+ ·00004

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Table 69b.

Phase of Moon.	Full.							Last Quarter.						
Bombay Astronomical Hours.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
h. m.														
0 12 ...	+ ·00004	− ·00003	− ·00006	− ·00010	− ·00007	− ·00001	− ·00004	− ·00010	+ ·00006	+ ·00006	+ ·00006	+ ·00008	− ·00004	+ ·00002
1 12 ...	+ ·00009	− ·00004	− ·00006	− ·00004	− ·00007	+ ·00004	− ·00001	− ·00013	+ ·00003	+ ·00008	+ ·00007	+ ·00008	− ·00006	+ ·00001
2 12 ...	+ ·00017	− ·00001	− ·00001	+ ·00004	·00000	+ ·00010	+ ·00005	− ·00015	+ ·00003	+ ·00004	+ ·00001	+ ·00004	− ·00007	− ·00001
3 12 ...	+ ·00010	+ ·00001	+ ·00002	+ ·00008	+ ·00003	+ ·00007	+ ·00005	− ·00010	− ·00001	+ ·00004	− ·00006	·00000	− ·00006	− ·00003
4 12 ...	− ·00001	+ ·00004	+ ·00010	+ ·00009	+ ·00008	+ ·00003	+ ·00005	+ ·00003	− ·00005	− ·00008	− ·00011	− ·00009	− ·00001	− ·00005
5 12 ...	− ·00007	+ ·00003	+ ·00009	+ ·00004	+ ·00006	− ·00002	+ ·00002	+ ·00008	− ·00002	− ·00012	− ·00007	− ·00010	+ ·00004	− ·00004
6 12 ...	+ ·00001	− ·00002	+ ·00003	− ·00004	+ ·00001	− ·00001	·00000	·00000	+ ·00001	− ·00004	+ ·00004	− ·00001	+ ·00002	·00000
7 12 ...	+ ·00002	− ·00003	− ·00001	− ·00003	− ·00002	·00000	− ·00001	− ·00001	+ ·00004	+ ·00001	+ ·00003	+ ·00002	+ ·00001	+ ·00001
8 12 ...	+ ·00003	− ·00001	− ·00003	− ·00005	− ·00004	+ ·00001	− ·00001	− ·00002	+ ·00004	·00000	+ ·00003	·00000	+ ·00002	+ ·00001
9 12 ...	+ ·00003	− ·00003	− ·00001	− ·00002	− ·00001	·00000	− ·00001	+ ·00002	+ ·00004	·00000	+ ·00002	+ ·00001	+ ·00003	+ ·00002
10 12 ...	+ ·00004	− ·00002	·00000	·00000	·00000	+ ·00002	+ ·00001	− ·00003	+ ·00003	− ·00001	+ ·00001	·00000	·00000	·00000
11 12 ...	+ ·00003	− ·00001	− ·00002	− ·00002	− ·00002	+ ·00001	− ·00001	− ·00002	·00000	+ ·00003	+ ·00002	+ ·00002	·00000	+ ·00001
12 12 ...	+ ·00004	− ·00001	− ·00001	+ ·00001	·00000	+ ·00002	+ ·00001	− ·00004	·00000	+ ·00002	·00000	+ ·00001	− ·00002	− ·00001
13 12 ...	+ ·00001	·00000	− ·00001	·00000	− ·00001	+ ·00001	·00000	− ·00003	+ ·00001	+ ·00003	·00000	+ ·00002	− ·00002	·00000
14 12 ...	·00000	− ·00002	+ ·00002	+ ·00001	+ ·00001	·00000	·00000	·00000	− ·00003	+ ·00001	− ·00001	+ ·00001	− ·00003	− ·00001
15 12 ...	− ·00002	·00000	+ ·00002	+ ·00002	+ ·00001	− ·00001	·00000	+ ·00003	− ·00002	+ ·00003	− ·00001	+ ·00002	·00000	+ ·00001
16 12 ...	− ·00004	− ·00004	·00000	+ ·00002	·00000	− ·00004	− ·00002	+ ·00003	+ ·00004	+ ·00002	− ·00002	+ ·00001	+ ·00003	+ ·00002
17 12 ...	− ·00006	− ·00002	·00000	+ ·00007	+ ·00003	− ·00004	·00000	+ ·00004	+ ·00002	− ·00002	− ·00004	− ·00001	+ ·00002	·00000
18 12 ...	− ·00010	− ·00001	+ ·00006	+ ·00008	+ ·00007	− ·00006	+ ·00001	+ ·00008	·00000	− ·00010	− ·00009	− ·00009	+ ·00004	− ·00003
19 12 ...	− ·00013	+ ·00001	+ ·00005	+ ·00004	+ ·00005	− ·00006	− ·00001	+ ·00011	·00000	− ·00007	− ·00007	− ·00007	+ ·00006	− ·00001
20 12 ...	− ·00010	+ ·00003	+ ·00002	− ·00001	+ ·00001	− ·00005	− ·00002	+ ·00009	− ·00007	− ·00002	− ·00002	− ·00003	+ ·00002	− ·00001
21 12 ...	− ·00009	+ ·00007	− ·00002	− ·00006	− ·00003	− ·00002	− ·00003	+ ·00009	− ·00011	− ·00001	+ ·00004	− ·00002	+ ·00002	·00000
22 12 ...	− ·00002	+ ·00009	− ·00006	− ·00007	− ·00004	·00000	− ·00002	+ ·00004	− ·00004	+ ·00003	+ ·00008	+ ·00004	+ ·00002	+ ·00003
23 12 ...	+ ·00002	+ ·00005	− ·00009	− ·00007	− ·00006	+ ·00001	− ·00002	− ·00001	− ·00001	+ ·00007	+ ·00009	+ ·00007	·00000	+ ·00003

TABLE 69*c*.

Typical excess solar diurnal variations, corresponding to the typical luni-solar varations of Table 68.

Bombay Astronomical Hours.	0	1	2	3	4	5	6	7	8	9	10	11
Nov. to Jan.	+ ·00006	+ ·00011	+ ·00013	+ ·00008	− ·00004	− ·00008	− ·00003	− ·00001	− ·00001	− ·00001	+ ·00001	+ ·00001
Feb. to April.	− ·00004	− ·00004	− ·00001	+ ·00001	+ ·00003	·00000	− ·00003	− ·00004	− ·00002	− ·00003	− ·00001	+ ·00001
May to July.	− ·00009	− ·00009	− ·00006	− ·00003	+ ·00001	+ ·00009	+ ·00002	− ·00001	− ·00001	+ ·00001	+ ·00001	·00000
Aug. to Oct.	− ·00007	− ·00004	+ ·00001	+ ·00006	+ ·00009	+ ·00005	− ·00002	− ·00001	− ·00001	·00000	·00000	·00000

Bombay Astronomical Hours.	12	13	14	15	16	17	18	19	20	21	22	23
Nov. to Jan.	+ ·00003	+ ·00002	+ ·00002	+ ·00001	·00000	− ·00003	− ·00007	− ·00010	− ·00008	− ·00004	·00000	+ ·00003
Feb. to April.	+ ·00003	+ ·00003	+ ·00003	+ ·00002	− ·00001	− ·00001	− ·00002	− ·00002	+ ·00004	+ ·00003	+ ·00003	+ ·00001
May to July.	+ ·00001	+ ·00001	+ ·00003	+ ·00001	+ ·00001	+ ·00004	+ ·00009	+ ·00007	+ ·00002	− ·00002	− ·00006	− ·00009
Aug. to Oct.	+ ·00001	+ ·00001	+ ·00001	+ ·00001	+ ·00002	+ ·00004	+ ·00008	+ ·00005	− ·00002	− ·00007	− ·00009	− ·00009

169*b*. A glance is sufficient to show that the curves of Plate XIX*a*, though throughout similar in general character to those of Plate XVIII, are decidedly of smaller range; and so considerable is the difference in this respect, that little doubt remains but that the variations in question have for their true period the lunar day. Regarding, then, the typical variation of each quarter as a lunar variation, we see, from Figs. 318 to 321, 325 to 328, 332 to 335, and 339 to 342 (Plate XVIII), that the variation has the same character at full moon as at new moon, but the phases occur twelve hours earlier, that it has the same character at last quarter as at first quarter, but the phases occur twelve hours earlier, and that the character of the variation at first quarter and last quarter is the reverse of that at new moon and full moon: otherwise and more fully stated the changes of phase consist in backward slips of six hours at each reversal of the character of the variation; or the lunar hour angle of the sun marks, at each exact quarter of the moon, what may be regarded as the initial phase of the typical variation or its opposite—of the typical variation at new moon and full moon and of its opposite at first quarter and last quarter. Having regard to this fixed relationship of the variation to the position of the sun, it is not difficult to conceive that a possible physical counterpart to the law of variation may lie in redistributions of the medium in which the solar magnetic action takes place being caused by lunar attraction upon the earth or its envelop or both.*

169*c*. The mode in which the reversal of character of the variation and seeming slipping of the phase occurs appears to be this: as the days increase after the exact quarter to which a typical curve, (say) Fig. 346 for November to January, corresponds, the principal inflexion wanes and becomes the later inflexion of the inverted curve, whilst the later inflexion fades away altogether; at the same time the earlier inflexion grows and becomes the principal inflexion of the inverted curve, whilst a new inflexion of reverse curvature appears in the place of the earlier one.

Certain combinations that have been made of lunar differences for different *solar days* after new moon will serve to illustrate the mode of growth and decay of the variation that has been described. The lunar differences used were for all the days in the month of January in all the years 1846 to 1870 and were formed into groups of thirty varieties, the first group comprising the six days from the 28th to the 3rd day after new moon (*i.e.* the 28th, 29th, 30th and 1st, 2nd and 3rd days after new moon), the second group from the 29th to the 4th day after new moon, and so on, the last or thirtieth group comprising the six days from the 27th to the 2nd after new moon. Having entered the lunar differences on solar abstract sheets, the means and variations were taken of the several groups, and the latter were converted into force, with the results shown in Table 69*d*.

* In the Transactions of the Royal Society of Edinburgh, Vol. XXVI, pages 735 to 757, there is a paper by the late John Allan Broun on the "Lunar Diurnal Variations of Magnetic Declination at Trevandrum," the second plate of which consists of curves which represent the variations for different months of the year and for each of the four quarters of the moon. The curves for the months of December and January give a typical curve almost identical with the winter curve of Bombay though of somewhat wider range, and they support in a remarkable manner the view taken above of the mode of growth and decay of the lunar diurnal variations for different ages of the moon. This view, it may be remarked, was founded on the Bombay observations alone, without any knowledge of Broun's investigation.

Table 69*d*.

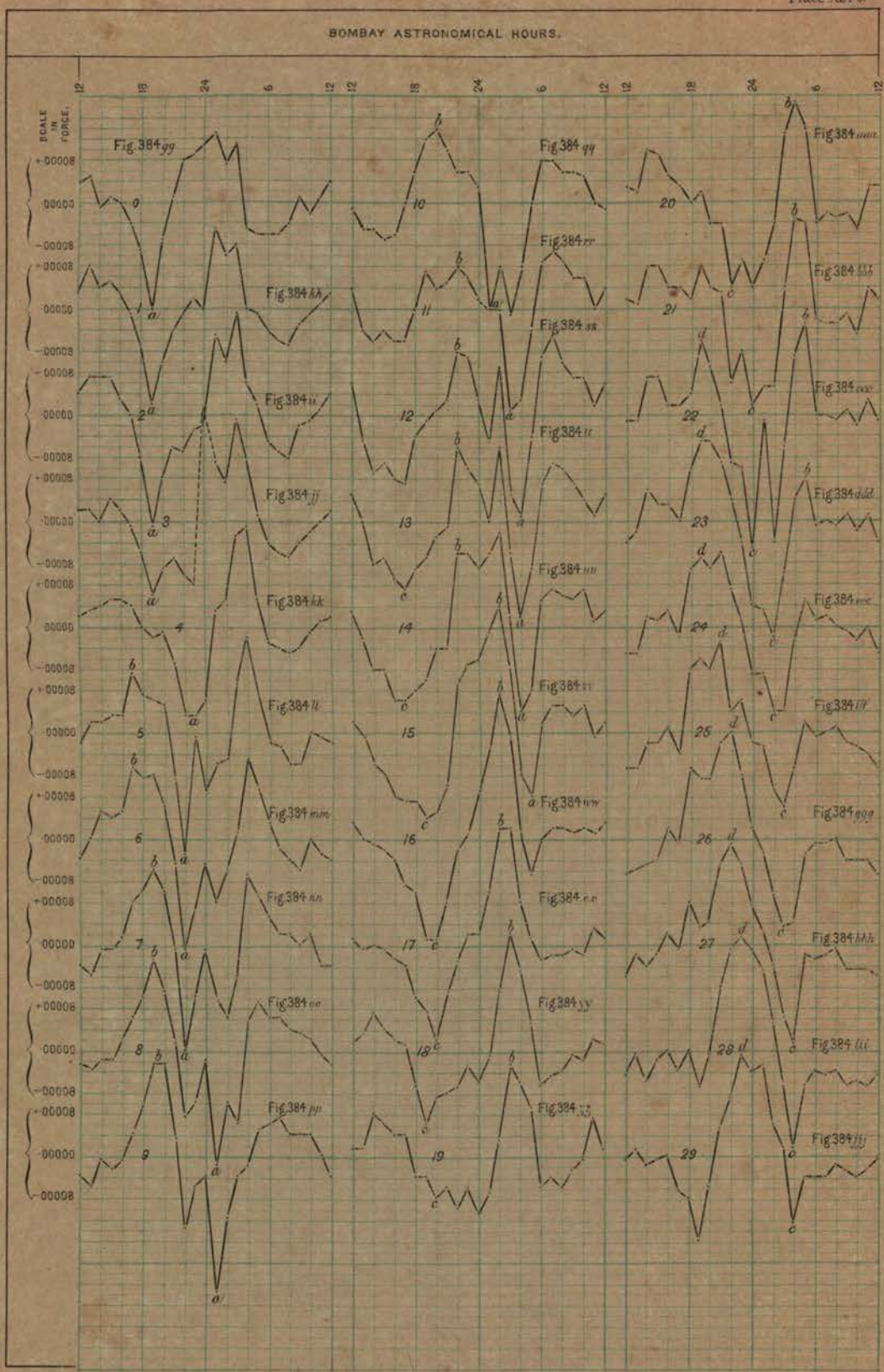
Bombay Astronomical Hours.	Mean Day after New Moon.														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
h. m.															
0 12... ...	+·00011	·00000	−·00002	+·00021	−·00014	−·00011	−·00005	−·00001	−·00002	−·00004	+·00003	+·00002	+·00003	+·00007	+·00011
1 12... ...	+·00013	+·00015	+·00015	+·00011	+·00003	−·00006	−·00012	−·00011	−·00022	−·00026	−·00020	·00000	−·00005	·00000	+·00014
2 12... ...	+·00007	+·00010	+·00010	+·00007	+·00005	−·00005	−·00006	−·00014	−·00010	−·00012	−·00012	·00000	+·00009	+·00014	+·00018
3 12... ...	+·00011	+·00012	+·00019	+·00019	+·00017	+·00009	+·00001	−·00006	−·00014	−·00004	−·00021	−·00019	−·00015	−·00006	+·00002
4 12... ...	−·00005	·00000	+·00006	+·00012	+·00019	+·00018	+·00015	+·00013	+·00005	−·00002	−·00012	−·00017	−·00019	−·00018	−·00016
5 12... ...	−·00006	−·00001	+·00002	+·00001	+·00005	+·00007	+·00009	+·00009	+·00009	+·00005	·00000	−·00004	−·00004	−·00009	−·00012
6 12... ..	−·00006	−·00004	−·00005	−·00004	−·00003	−·00002	+·00003	+·00005	+·00006	+·00006	+·00008	+·00009	+·00011	+·00007	+·00005
7 12... ...	−·00006	−·00006	−·00007	−·00006	−·00004	−·00003	−·00002	+·00002	+·00006	+·00007	+·00008	+·00011	+·00015	+·00011	+·00007
8 12... ...	−·00004	−·00007	−·00008	−·00007	−·00005	−·00006	−·00004	+·00002	+·00004	+·00004	+·00006	+·00009	+·00010	+·00010	+·00006
9 12... ...	+·00001	−·00003	−·00002	−·00004	−·00004	−·00006	−·00006	·00000	+·00003	+·00004	+·00006	+·00006	+·00007	+·00007	+·00005
10 12... ...	−·00002	−·00001	−·00001	−·00002	−·00001	·00000	·00000	+·00002	+·00002	+·00004	+·00005	+·00006	+·00007	+·00004	+·00007
11 12... ...	+·00001	+·00001	+·00001	·00000	+·00001	−·00001	−·00003	−·00004	−·00001	·00000	·00000	·00000	+·00002	+·00001	+·00001
12 12... ...	+·00004	+·00003	+·00004	+·00002	+·00002	−·00002	−·00004	−·00004	−·00003	−·00004	−·00001	+·00004	+·00006	+·00005	+·00003
13 12... ...	+·00005	+·00008	+·00007	+·00002	+·00003	+·00002	·00000	−·00006	−·00004	−·00006	−·00005	−·00004	−·00005	·00000	−·00002
14 12... ...	−·00001	+·00004	+·00007	·00000	+·00004	+·00002	+·00005	−·00001	−·00002	−·00001	−·00005	−·00006	−·00011	−·00008	−·00008
15 12... ...	+·00001	+·00005	+·00007	+·00004	+·00005	+·00003	+·00004	−·00001	−·00002	−·00003	−·00007	−·00004	−·00009	−·00007	−·00008
16 12... ...	·00000	+·00003	+·00003	+·00002	+·00005	+·00003	+·00005	+·00001	+·00002	−·00001	−·00006	−·00006	−·00012	−·00011	−·00014
17 12... ...	−·00004	−·00001	·00000	−·00001	+·00004	+·00011	+·00013	+·00008	+·00006	+·00004	·00000	−·00006	−·00013	−·00013	−·00014
18 12... ...	−·00009	−·00007	−·00008	−·00006	·00000	+·00007	+·00011	+·00010	+·00010	+·00009	+·00006	·00000	−·00004	−·00009	−·00012
19 12... ...	−·00020	−·00018	−·00021	−·00014	−·00002	+·00006	+·00012	+·00014	+·00017	+·00017	+·00012	+·00007	−·00001	−·00007	−·00010
20 12... ...	−·00007	−·00010	−·00012	−·00009	−·00001	+·00005	+·00006	+·00010	+·00011	+·00017	+·00014	+·00004	+·00001	−·00003	−·00004
21 12	+·00001	−·00004	−·00006	−·00007	−·00007	−·00009	−·00005	−·00001	+·00001	+·00003	+·00010	+·00005	+·00003	−·00001	−·00004
22 12... ...	+·00008	−·00001	−·00007	−·00010	−·00017	−·00023	−·00021	−·00020	−·00013	−·00014	+·00006	+·00008	+·00012	+·00014	+·00014
23 12... ...	+·00009	+·00002	−·00003	−·00012	−·00017	−·00001	−·00014	−·00010	−·00010	−·00006	+·00006	+·00006	+·00011	+·00010	+·00014

COLABA OBSERVATORY.

EXCESS SOLAR-DIURNAL VARIATION OF DECLINATION FOR EACH DAY OF THE MOON'S AGE.

MONTH OF JANUARY—1846 TO 1870.

Plate XIX 6.



THE MOON'S MEAN AGES ARE THE NUMBERS MARKED ON THE RESPECTIVE CURVES.

Government Printing Office Poona 1879.

TABLE 69*d*—*continued.*

Bombay Astronomical Hours.			MEAN DAY AFTER NEW MOON.													
			15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
h.	m.																
0	12...	...	+·00014	+·00009	+·00002	−·00006	−·00011	−·00016	−·00018	−·00025	−·00016	−·00009	−·00002	+·00002	+·00007	+·00019	+·00016
1	12...	...	+·00019	+·00017	+·00010	−·00001	−·00007	−·00011	−·00015	−·00001	−·00017	−·00009	−·00003	−·00003	+·00002	+·00015	+·00017
2	12...	...	+·00024	+·00027	+·00022	+·00011	+·00003	−·00004	−·00015	−·00024	−·00022	−·00016	−·00011	−·00011	−·00004	+·00005	+·00006
3	12...	...	+·00012	+·00019	+·00022	+·00022	+·00017	+·00013	+·00004	−·00006	−·00010	−·00016	−·00014	−·00017	−·00014	−·00007	+·00001
4	12...	...	−·00008	+·00001	+·00008	+·00015	+·00014	+·00019	+·00017	+·00011	+·00004	−·00003	−·00007	−·00016	−·00019	−·00019	−·00013
5	12...	...	−·00012	−·00007	+·00001	+·00005	+·00009	+·00014	+·00016	+·00017	+·00008	+·00005	+·00002	−·00003	−·00002	−·00007	−·00004
6	12...	...	+·00002	·00000	−·00003	−·00007	−·00006	−·00004	−·00002	·00000	−·00001	+·00001	−·00001	−·00001	−·00003	−·00004	−·00004
7	12...	...	+·00005	+·00002	−·00002	−·00005	−·00004	−·00002	−·00003	·00000	·00000	+·00002	·00000	−·00001	−·00002	−·00005	−·00004
8	12...	...	+·00005	+·00002	−·00002	−·00004	−·00006	−·00003	−·00003	−·00001	−·00001	·00000	+·00001	·00000	−·00001	−·00004	−·00002
9	12...	...	+·00003	+·00001	−·00001	−·00001	−·00003	−·00002	−·00001	+·00001	+·00001	−·00001	−·00002	−·00004	−·00005	−·00007	−·00003
10	12...	...	+·00005	+·00002	−·00002	−·00002	−·00001	−·00005	−·00005	−·00002	−·00002	−·00003	−·00003	−·00004	−·00005	−·00006	−·00004
11	12...	...	−·00001	+·00001	+·00003	+·00002	+·00007	+·00003	+·00004	+·00003	+·00001	·00000	−·00004	−·00004	−·00005	−·00007	−·00003
12	12...	...	+·00002	+·00003	+·00001	+·00001	+·00001	+·00003	+·00002	−·00001	−·00004	−·00005	−·00007	−·00007	−·00006	−·00005	−·00001
13	12...	...	−·00001	·00000	−·00001	+·00003	+·00001	+·00002	+·00001	−·00001	−·00002	−·00005	−·00007	−·00006	−·00002	−·00001	+·00001
14	12...	...	−·00006	−·00001	·00000	+·00007	+·00008	+·00010	+·00008	+·00007	+·00006	+·00002	−·00002	−·00005	−·00004	−·00006	−·00002
15	12...	...	−·00008	−·00002	−·00001	+·00004	+·00006	+·00009	+·00008	+·00007	+·00003	+·00001	−·00002	−·00004	−·00002	−·00002	−·00001
16	12...	...	−·00012	−·00004	−·00003	+·00002	+·00004	+·00005	+·00004	+·00002	+·00003	+·00003	+·00001	+·00002	+·00002	·00000	·00000
17	12...	...	−·00013	−·00009	−·00004	+·00001	+·00004	+·00003	+·00004	+·00002	·00000	−·00002	−·00004	−·00001	−·00001	−·00004	−·00007
18	12...	...	−·00013	−·00010	−·00010	−·00007	−·00004	·00000	+·00002	+·00004	+·00010	+·00011	+·00012	+·00013	+·00008	·00000	−·00008
19	12...	...	−·00016	−·00019	−·00013	−·00014	−·00004	+·00002	+·00008	+·00014	+·00015	+·00013	+·00014	+·00011	+·00003	−·00007	−·00016
20	12...	...	−·00015	−·00019	−·00018	−·00009	−·00008	−·00004	+·00004	+·00009	+·00015	+·00011	+·00012	+·00011	+·00004	−·00001	−·00006
21	12...	...	−·00010	−·00012	−·00009	−·00008	−·00006	−·00004	+·00003	+·00002	+·00011	+·00014	+·00017	+·00018	+·00015	+·00012	+·00005
22	12...	...	+·00009	−·00002	−·00003	−·00007	−·00010	−·00016	−·00014	−·00009	+·00004	+·00007	+·00004	+·00020	+·00019	+·00019	+·00011
23	12...	...	+·00013	+·00001	+·00002	−·00003	−·00006	−·00011	−·00008	−·00010	−·00004	+·00001	+·00006	+·00012	+·00015	+·00021	+·00019

Curves representing these numbers form Figs. 384*gg* to 384*iij* on Plate XIX*b*.

169*d*. On these curves, which may be taken to represent the mean variations for the several days after new moon, in order, in the month of January, the relative growth and decay of the same inflexion is indicated by the marks *a*, *a*, *a*, *a*, &c. . . . . in one case; *b*, *b*, *b*, &c. in another; *c*, *c*, *c*, &c. in another, and *d*, *d*, *d*, &c. in another. The progression in the solar time of these occurrences, also accords with our conclusion that the variation has for its period rather the lunar than the solar day, though the rate of progression is much less than one day *per* lunation. We see, however, from Figs. 318 to 321, 325 to 328, 332 to 335, and 339 to 342, that what is lacking in the rate of progress of individual inflexions must be made up in delayed outbreak of new inflexions.

170. The lunar diurnal variations for each quarter, for the summer and winter half-years, and for the full year, irrespective of phase or declination of the moon, are shown in Table 70 and by curves in Figs. 378 to 384. Also the mean lunar diurnal variations for each year separately are shown numerically in Table 71.

TABLE 70.

Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0 ...	+ ·00011	+ ·00002	− ·00009	− ·00007	− ·00008	+ ·00007	− ·00001
1 ...	+ ·00011	+ ·00001	− ·00007	− ·00004	− ·00006	+ ·00007	− ·00000
2 ...	+ ·00009	− ·00001	− ·00003	+ ·00002	− ·00001	+ ·00005	+ ·00002
3 ...	+ ·00004	− ·00004	+ ·00001	+ ·00005	+ ·00002	+ ·00001	+ ·00002
4 ...	− ·00001	− ·00005	+ ·00002	+ ·00007	+ ·00004	− ·00002	+ ·00001
5 ...	− ·00007	− ·00004	+ ·00007	+ ·00007	+ ·00007	− ·00005	+ ·00001
6 ...	− ·00011	− ·00003	+ ·00006	+ ·00005	+ ·00005	− ·00007	− ·00001
7 ...	− ·00011	− ·00001	+ ·00004	+ ·00001	+ ·00004	− ·00007	− ·00001
8 ...	− ·00011	− ·00002	+ ·00003	− ·00002	+ ·00001	− ·00006	− ·00003
9 ...	− ·00008	·00000	− ·00003	− ·00004	− ·00002	− ·00005	− ·00004
10 ...	− ·00002	+ ·00002	− ·00007	− ·00007	− ·00007	− ·00001	− ·00004
11 ...	+ ·00004	+ ·00004	− ·00007	− ·00007	− ·00007	+ ·00003	− ·00002
12 ...	+ ·00007	+ ·00005	− ·00009	− ·00004	− ·00006	+ ·00006	·00000
13 ...	+ ·00009	+ ·00001	− ·00006	− ·00001	− ·00004	+ ·00006	+ ·00001
14 ...	+ ·00006	+ ·00003	− ·00002	+ ·00003	·00000	+ ·00005	+ ·00002
15 ...	+ ·00005	·00000	+ ·00002	+ ·00006	+ ·00003	+ ·00004	+ ·00003
16 ...	− ·00001	+ ·00001	+ ·00007	+ ·00008	+ ·00007	·00000	+ ·00004
17 ...	− ·00003	− ·00001	+ ·00009	+ ·00006	+ ·00007	− ·00001	+ ·00003
18 ...	− ·00006	− ·00002	+ ·00010	+ ·00005	+ ·00007	− ·00004	+ ·00002
19 ...	− ·00007	− ·00001	+ ·00008	+ ·00002	+ ·00006	− ·00005	·00000
20 ...	− ·00005	− ·00001	+ ·00005	− ·00001	+ ·00003	− ·00004	·00000
21 ...	− ·00001	+ ·00003	·00000	− ·00005	− ·00001	− ·00001	− ·00001
22 ...	+ ·00003	+ ·00001	− ·00004	− ·00007	− ·00005	+ ·00002	− ·00002
23 ...	+ ·00006	·00000	− ·00007	− ·00007	− ·00007	+ ·00003	− ·00002
Number of lunar days' observations in abstract ...	1786	1780	1860	1835	3683	3578	7261

TABLE 71.

Bombay Lunar Hour.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.
0 ...	+ ·00002	+ ·00002	+ ·00004	− ·00004	+ ·00002	− ·00005	+ ·00001	− ·00003	+ ·00007	− ·00003	− ·00002	− ·00002	− ·00007
1 ...	+ ·00004	− ·00002	+ ·00004	+ ·00001	− ·00004	− ·00003	− ·00001	+ ·00007	+ ·00008	− ·00004	+ ·00005	− ·00001	− ·00006
2 ...	+ ·00009	− ·00003	+ ·00006	+ ·00002	+ ·00001	+ ·00001	·00000	+ ·00010	+ ·00007	− ·00007	+ ·00007	+ ·00005	·00000
3 ...	+ ·00010	− ·00001	+ ·00002	+ ·00002	·00000	+ ·00004	+ ·00001	+ ·00007	+ ·00009	− ·00005	+ ·00008	+ ·00004	·00000
4 ...	+ ·00011	− ·00001	− ·00003	+ ·00003	− ·00003	+ ·00006	+ ·00001	+ ·00006	+ ·00004	− ·00006	+ ·00004	+ ·00004	− ·00001
5 ...	+ ·00004	− ·00002	·00000	+ ·00001	− ·00001	+ ·00001	+ ·00003	+ ·00010	·00000	− ·00006	+ ·00006	+ ·00003	+ ·00002
6 ...	+ ·00005	− ·00001	·00000	− ·00003	− ·00002	+ ·00007	·00000	+ ·00006	+ ·00001	− ·00002	+ ·00005	+ ·00001	+ ·00005
7 ...	+ ·00003	+ ·00001	·00000	− ·00006	− ·00002	− ·00001	− ·00002	+ ·00004	− ·00001	− ·00000	+ ·00003	+ ·00007	+ ·00006
8 ...	+ ·00001	+ ·00001	− ·00005	− ·00008	− ·00004	− ·00002	+ ·00003	− ·00001	− ·00004	− ·00002	+ ·00002	− ·00010	·00000
9 ...	− ·00005	− ·00002	− ·00003	− ·00008	− ·00007	− ·00003	·00000	− ·00001	− ·00007	− ·00003	+ ·00001	− ·00009	− ·00001
10 ...	− ·00008	− ·00007	− ·00004	− ·00002	− ·00006	− ·00005	+ ·00004	− ·00009	− ·00010	− ·00001	+ ·00001	+ ·00009	+ ·00001
11 ...	− ·00008	− ·00006	− ·00002	·00000	− ·00001	− ·00002	·00000	− ·00002	− ·00010	− ·00000	− ·00003	− ·00008	− ·00002
12 ...	− ·00009	− ·00005	− ·00001	− ·00002	− ·00001	− ·00002	+ ·00002	+ ·00001	− ·00008	+ ·00003	− ·00005	− ·00004	− ·00003
13 ...	− ·00006	− ·00004	·00000	·00000	·00000	+ ·00001	+ ·00007	+ ·00001	− ·00007	+ ·00001	− ·00003	− ·00001	− ·00002
14 ...	− ·00004	− ·00002	+ ·00001	+ ·00004	+ ·00004	− ·00003	+ ·00007	+ ·00003	− ·00004	+ ·00006	− ·00002	+ ·00001	+ ·00001
15 ...	+ ·00003	+ ·00003	+ ·00004	+ ·00004	+ ·00002	+ ·00005	+ ·00002	− ·00005	− ·00002	+ ·00006	+ ·00004	+ ·00002	+ ·00002
16 ...	+ ·00006	+ ·00008	− ·00004	+ ·00005	+ ·00006	+ ·00003	·00000	− ·00006	− ·00001	+ ·00006	·00000	+ ·00005	+ ·00002
17 ...	+ ·00003	+ ·00007	− ·00003	+ ·00006	+ ·00004	·00000	·00000	− ·00001	− ·00001	+ ·00003	− ·00004	+ ·00006	+ ·00006
18 ...	+ ·00005	+ ·00004	− ·00003	+ ·00008	+ ·00005	− ·00001	− ·00004	− ·00001	− ·00004	+ ·00002	− ·00007	+ ·00005	+ ·00005
19 ..	− ·00004	+ ·00002	− ·00002	+ ·00007	+ ·00004	+ ·00001	− ·00007	− ·00006	− ·00002	+ ·00004	− ·00005	+ ·00007	+ ·00003
20 ...	− ·00006	+ ·00002	+ ·00002	− ·00001	·00000	·00000	− ·00004	− ·00001	+ ·00004	+ ·00002	− ·00005	+ ·00007	+ ·00003
21 ...	− ·00008	+ ·00003	+ ·00001	·00000	+ ·00001	− ·00002	− ·00004	− ·00008	+ ·00005	+ ·00002	− ·00003	+ ·00004	− ·00002
22 ...	− ·00005	+ ·00002	+ ·00001	− ·00004	+ ·00001	− ·00002	− ·00006	− ·00007	+ ·00008	+ ·00001	− ·00002	·00000	− ·00005
23 ...	− ·00003	·00000	− ·00003	− ·00005	·00000	− ·00001	− ·00003	− ·00007	+ ·00009	− ·00002	− ·00003	+ ·00001	− ·00007
Number of lunar days' observations in abstract...	301	294	291	298	298	296	295	293	295	289	287	294	289

TABLE 71—*continued.*

Bombay Lunar Hour.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.
0	·00000	− ·00005	·00000	+ ·00004	·00000	− ·00001	− ·00002	− ·00001	− ·00006	− ·00001	− ·00001	− ·00004
1	− ·00001	+ ·00001	+ ·00002	− ·00002	+ ·00002	+ ·00001	− ·00004	+ ·00003	− ·00001	− ·00002	− ·00002	+ ·00001
2	+ ·00001	− ·00003	+ ·00001	+ ·00001	+ ·00003	− ·00004	+ ·00001	+ ·00002	+ ·00009	− ·00003	+ ·00001	+ ·00001
3	+ ·00001	+ ·00002	·00000	+ ·00001	+ ·00001	− ·00004	− ·00002	− ·00005	+ ·00006	− ·00006	+ ·00004	+ ·00001
4	+ ·00001	− ·00006	+ ·00001	+ ·00002	− ·00002	− ·00002	− ·00005	− ·00002	+ ·00007	− ·00005	− ·00001	·00000
5	+ ·00001	− ·00005	+ ·00003	+ ·00004	− ·00003	− ·00002	− ·00007	·00000	+ ·00006	− ·00005	+ ·00001	·00000
6	+ ·00003	− ·00010	+ ·00002	+ ·00001	− ·00003	− ·00001	− ·00013	− ·00008	+ ·00005	− ·00009	+ ·00001	− ·00006
7	·00000	− ·00004	+ ·00005	+ ·00004	− ·00005	− ·00006	− ·00008	− ·00003	·00000	− ·00005	− ·00003	− ·00008
8	− ·00005	− ·00007	+ ·00002	− ·00002	− ·00006	− ·00006	− ·00004	− ·00003	+ ·00007	− ·00006	− ·00003	− ·00006
9	− ·00004	− ·00004	− ·00001	− ·00008	− ·00005	− ·00005	− ·00007	− ·00002	+ ·00003	− ·00003	·00000	− ·00010
10	− ·00002	− ·00002	− ·00005	− ·00011	− ·00001	·00000	− ·00009	− ·00003	+ ·00008	− ·00004	− ·00003	− ·00008
11	+ ·00001	− ·00003	− ·00005	− ·00005	+ ·00001	+ ·00003	·00000	− ·00001	+ ·00009	− ·00002	+ ·00006	− ·00003
12	+ ·00007	+ ·00004	− ·00003	− ·00002	− ·00001	+ ·00007	+ ·00004	+ ·00005	+ ·00004	− ·00002	− ·00001	+ ·00002
13	+ ·00002	+ ·00008	·00000	+ ·00001	+ ·00001	+ ·00001	+ ·00002	+ ·00005	+ ·00001	·00000	+ ·00002	+ ·00005
14	+ ·00001	+ ·00005	− ·00001	+ ·00002	+ ·00010	+ ·00005	+ ·00005	+ ·00012	− ·00003	− ·00001	+ ·00004	+ ·00007
15	− ·00002	+ ·00004	+ ·00004	+ ·00002	+ ·00008	+ ·00007	+ ·00007	+ ·00005	− ·00002	+ ·00004	+ ·00004	+ ·00010
16	+ ·00002	+ ·00006	+ ·00003	+ ·00001	+ ·00006	+ ·00009	+ ·00008	+ ·00005	+ ·00002	+ ·00006	+ ·00003	+ ·00011
17	+ ·00002	+ ·00006	− ·00001	·00000	+ ·00001	+ ·00007	+ ·00011	+ ·00002	+ ·00001	+ ·00009	+ ·00003	+ ·00004
18	− ·00002	+ ·00010	+ ·00001	·00000	− ·00001	+ ·00004	+ ·00008	+ ·00002	− ·00007	+ ·00013	+ ·00006	+ ·00001
19	+ ·00001	+ ·00008	·00000	− ·00002	− ·00005	− ·00002	+ ·00004	·00000	− ·00010	+ ·00009	+ ·00005	+ ·00002
20	− ·00005	+ ·00005	− ·00002	·00000	− ·00006	− ·00002	+ ·00006	− ·00001	− ·00010	+ ·00008	− ·00006	+ ·00001
21	+ ·00001	·00000	− ·00005	+ ·00006	+ ·00003	− ·00003	+ ·00004	− ·00004	− ·00012	+ ·00004	− ·00008	+ ·00003
22	− ·00001	− ·00003	·00000	+ ·00002	·00000	− ·00004	+ ·00003	− ·00003	− ·00012	− ·00001	+ ·00005	+ ·00002
23	− ·00001	− ·00005	− ·00001	+ ·00002	·00000	− ·00002	− ·00006	− ·00003	− ·00009	− ·00001	− ·00005	− ·00005
Number of lunar days' observations in abstract	285	289	269	289	291	295	292	288	292	268	292	291

171. Objection may be taken to the process used in the formation of lunar differences on the ground that the solar diurnal variation, being itself subject—at certain seasons—to rapid growth or decay, is not completely eliminated by the subtraction of monthly final normals from the observations. The seasons at which the solar diurnal variation changes most rapidly are near the equinoxes, so we have chosen one of these—August to October—and one of the principal sixteen varieties of luni-solar positions, that viz., of new moon with the moon's declination changing from north to south, for which to calculate the effect that would be produced on the resulting lunar diurnal variation if daily, instead of merely monthly, solar diurnal normals were used. The daily normals adopted for this purpose were obtained from pairs of adjacent monthly normals by assuming that the change from one hour in the first of the months to the same hour in the second of the months took place at a uniform rate. The excesses of the daily over the monthly normal may now be supposed to be entered, for each day, in monthly abstracts, and then to be transferred to lunar abstracts (just as the original lunar differences were), on which the hourly means would be taken. The actual proceeding, though equivalent to this in its results, was much less laborious, and for the case in question gave for the lunar hours, in order, from 0 to 23

$-\cdot00002, -\cdot00002, -\cdot00001, -\cdot00001, +\cdot00001, +\cdot00001+\cdot00001, \cdot00000,$
$-\cdot00001, \cdot00000, \cdot00000, \cdot00000, \cdot00000, \cdot00000, \cdot00000, +\cdot00001, +\cdot00001,$
$+\cdot00001, +\cdot00001, +\cdot00001, \cdot00000, +00001, \cdot00000, -\cdot000002.$

Comparing these numbers with the lunar diurnal variations, for the same case, given in column 3 of Table 61, and which has a definite character and a range of ·00030, we see that it is unimportant, when observations extending over a long period are dealt with, whether monthly or daily normals, of the solar diurnal variation are used in the calculation of lunar differences: and as the case that we have chosen for examination is presumably one that is most affected in this way, we may conclude that in all the sixteen principal cases of luni-solar positions, the errors of the deduced variations due to the adoption of monthly normals are insignificant.

APPENDIX III.

On the Solar and Lunar variations of the horizontal component of the Earth's magnetic force at Bombay.

172. The observations discussed in the following pages were made at the Government Observatory at Bombay, during the years 1846 to 1872, and were taken under the same conditions and in the same manner as the declination observations dealt with in the preceding paper.

173. The instrument used was made by Grubb of Dublin and is one of those described in the report (of 1840) of the Committee of Physics of the Royal Society: it consists of a rectangular bar magnet suspended horizontally, and carrying a collimator scale, by means of which its position can be determined from time to time by reading the scale with a fixed telescope properly placed. The magnet is of dimensions 15 inches by 0·87 inch by 0·24 inch, and it rests with its broad surface horizontal in a stirrup that is hooked on to the ends of the axis of a small pulley, round the groove of which passes a supporting wire: the suspension wire is of silver, and is 30·50 inches long (from axis of screw to axis of pulley), being protected (but not concealed from view) by a glass tube 1·3 inch in diameter: the bottom of the glass tube rests upon the top of a cylindrical mahogany box (8·5 inches in height) which surrounds the magnet, and the top supports a horizontal divided circle (the torsion-circle), and a brass cross-piece to which the suspension wire is attached. Under the cross-piece is fixed a double screw, between the threads of which pass the two threads of the suspension wire, and by turning which the distance apart of these two threads is regulated. The glass tube is secured in a vertical position by a mahogany cross bar which has a circular hole in the middle of it that fits over the upper end of the tube, and which is fixed at its extremities to two copper pillars whose feet are screwed into the marble basement of the instrument; and the upper aperture of the tube with the attachments is screened from the outer air and dust by an inverted hemispherical glass vessel. The collimator consists of a brass tube with a lens at one end and a finely divided scale in the principal focus of the lens at the other, and it is attached below the stirrup by means of a pin round which it can rotate in azimuth: it has also an azimuth circle with an index that can be set on either of two marks, one of which implies that the collimator is nearly parallel to the axis of the magnet and the other that it deviates 90° from this position. The vertical lines which form the scale—280 in number—are equidistant and generally of uniform length; but every fifth division is slightly and every tenth division considerably prolonged, and over the tenth divisions numbers are marked in consecutive order, thus allowing a numerical designation to be given with facility to every point of the scale when viewed by the telescope. To permit the scale to be viewed through its lens by a teleseope outside the mahogany box, the latter has two small windows of flat glass suitably inserted in its curved side, and a lamp is placed on a stool to the eastward of the masonry pillar which supports the instrument, and is kept constantly burning. The joints and crevices, and, for greater security, the whole outside surface of the cylindrical box was covered with paper to keep out small spiders or other insects. The telescope is firmly fixed with its line of collimation nearly at right angles to the magnetic meridian. The adjustment is made with the north end of the magnet turned to westward, so that increase of scale-reading implies an increase of the horizontal force.

174. The continuity of the record was interrupted or interfered with on the following occasions:—

(1). On the 18th November 1849, when a new vertical force magnet was introduced. As the total effect of the magnet was less than ·03 scale-division no correction has been applied on this account.

(2). On the 27th December 1850, when (1) the old suspension wire was broken and a new one substituted, (2) the magnet and fittings were cleaned, and (3) the instrument was re-adjusted. At the beginning of the operations a small cobweb was found connecting the magnet and the box, but on breaking it no change of scale-reading was found.

(3). On the 21st January 1853, when the suspension wires were brought closer together at top.

(4). On the 30th December 1855, when the torsion arm was turned and the distance apart of the wires at top altered.

(5). On the 23rd January 1856, when the declination magnet was re-magnetised —increasing the scale-reading of the horizontal force magnetometer by 1·14.

(6). On the 16th June 1866, when a new reading wire was inserted in the reading telescope.

(7). From the 13th February to the 1st October, and from the 4th October to the 31st December 1872, a small magnet was placed end-on, so as to bring the scale, the reading of which had approached its upper limit, back into the field of view. On the 25th June it was found that some time during the interval since the 13th February the small magnet had rolled slightly out of place. Its effect in this position was to reduce the scale-reading by 5·33— in the former position by 5·43: its effect on the 4th October was still 5·33. When the magnet was finally removed in January 1873, it was again found to have moved aside slightly and its effect was found to be 5·58 scale-divisions.

(8). From the 1st to the 4th October 1872 the small magnet was removed to allow of deflection experiments being made.

(9). On the 1st December 1853, when a new reading wire was inserted in the reading telescope. As the wire-plate was adjusted to eliminate any error of collimation, this appears to have produced no effect on the observations,

and (10). On the 26th September 1872, when the enclosing box was opened and a search was made for spider lines: none were seen, but the hand was passed round the magnet, without touching it, so as to break any that might be there. On re-adjusting the instrument in January 1873 a single small white spider was found inside the micrometer screw-head at the top of the suspension tube.

175. The method of reduction adopted was the same as is described, as having been applied to the declination observations, in paragraph 131 of the preceding paper. The entries made upon the monthly abstracts were of hourly scale-readings, after correction to the standard temperature 82° Faht., and disturbances were separated and final normals and their diurnal variations found—first in scale-readings, and these were then converted into millimetre-milligramme-second units of force.

176. The correction applied for the temperature t was $(t-82)\times 0{\cdot}20$ from 1847 to 1850, $(t-82)\times 0{\cdot}21$ from 1851 to 1855, and $(t-82)\times 0{\cdot}15$ from 1856 to 1872, the observed scale-reading being increased when t was above 82° and decreased when t was below 82°. The modes of determining the temperature coefficient, both by natural and artificial variations of temperature, will be described further on.

177. The separating value fixed upon was ·00334 unit of force, or in scale-divisions—

0·93 from 1846·50 to 1851·00
0·96 for January 1851
0·95 for February 1851
0·94 for March 1851
0·93 from 1851·25 to 1853·00
0·91 from 1853·00 to 1856·00
and 0·60 from 1856·00 to 1873·00.

178. The following statement shows all the irregularities of procedure that have been rendered necessary by interruptions of the record and extraneous influences upon the magnet:—

(1). December 27, 1850 to January 7, 1851—Rejected on account of re-adjustment and rapid change of scale-reading due to gradual untwisting of the suspension wire.

(2). January 8 to April 30, 1851—Before using the abstracts for the separation of disturbances daily corrections applied to eliminate the effect of untwisting of the suspension wire.

(3). January 21 to 24, 1853—Rejected on account of re-adjustment.

(4). January 25 to 31, 1853—Entries increased by +12·06, the excess of the mean for six days before over the mean for the six days after the re-adjustment.

(5). December 30 and 31, 1855—Rejected on account of re-adjustment.

(6). January 24 to 31, 1856—Entries increased by −1·14, the effect of re-magnetising the declination magnet.

(7). June 16, 1866—Rejected—incomplete day, reading wire of telescope being broken.

(8). June 1 to 15 and 18 to 30, 1866—Formed into two distinct abstracts for the separation of disturbances; and the final normals of the two abstracts were combined, with appropriate weights, to find final normals for the full month.

(9). November 1 to 15 and December 17 to 31, 1868—Combined to form one month's abstract, which was adopted both for November and December: entries for the days in December increased by +·21, the supposed effect of excavating for the magnetograph room.

(10). November 16 to 30 and December 1 to 16, 1868—Rejected—excavation for the magnetograph room having been in progress during that time.

(11). February 13 to 29, 1872. Entries increased by 5·38, the effect of the small magnet placed as a deflector.

(12). March to June, 1872. Final normals increased by 5·38, the effect of the small magnet.

(13). July to December 1872. do. do. 5·45, do. do.

(14). October 1 to 4, 1872. Entries increased by −5·33, the effect of removing the small magnet.

And it has, occasionally, been necessary to interpolate a missing entry, but no incomplete days have been embodied in the monthly abstracts.

From January to May 1847 observations were taken at the even hours of the day only, and consequently the disturbances separated are for those hours only; but in calculating the mean diurnal variations for the five months named, values of the 'final normals' were interpolated for the odd hours by simply taking the means of those for the preceding and following even hours.

179. The following table shows the number of complete days' observations, comprised in the records made use of,* in each month of the twenty-six and a half years:—

TABLE 72.

YEAR.	MONTH.												Total in Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
1846 ...	...	...	...	...	...	...	27	26	26	26	26	27	158
1847 ...	26	24	27	26	26	26	26	27	26	26	26	26	312
1848 ...	26	25	27	25	27	26	26	26	25	27	26	25	312
1849 ...	27	24	26	26	27	25	27	27	25	27	26	24	311
1850 ...	27	24	26	26	27	25	27	27	25	27	26	21	308
1851 ...	21	24	26	26	27	25	27	26	26	27	25	26	306
1852 ...	26	25	27	26	26	26	25	27	26	26	26	26	312
1853 ...	23	24	25	24	27	26	26	26	26	25	26	25	303
1854 ...	27	24	26	24	26	26	26	26	25	26	26	25	307
1855 ...	27	24	25	25	26	25	27	26	25	27	25	23	305
1856 ...	27	25	24	26	26	25	27	25	26	26	25	26	308
1857 ...	26	25	25	25	26	26	27	24	26	25	26	26	307
1858 ...	26	23	27	25	25	26	26	26	26	25	24	25	304
1859 ...	26	24	25	24	26	26	25	25	26	25	26	25	303
1860 ...	26	24	25	25	26	25	26	27	25	27	25	24	305
1861 ...	27	24	23	26	26	25	27	25	26	27	24	25	305
1862 ...	27	23	25	25	26	25	27	25	26	26	25	24	304
1863 ...	26	24	25	25	26	26	27	25	26	26	25	25	306
1864 ...	26	25	25	25	26	26	26	26	26	25	26	25	307
1865 ...	26	23	26	24	26	26	26	27	25	26	26	24	305
1866 ...	26	23	25	25	26	25	26	26	25	27	25	25	304
1867 ...	26	24	24	25	26	25	26	26	25	26	26	25	304
1868 ...	26	24	25	25	25	26	27	25	26	26	12	12	279
1869 ...	25	22	26	26	25	26	27	25	26	26	25	26	305
1870 ..	25	23	26	25	25	26	26	26	26	25	26	27	306
1871 ...	26	23	26	24	26	26	26	26	26	26	25	25	305
1872 ...	26	25	23	26	26	25	27	27	25	26	26	25	307

* The observations of July to December 1846 were made use of for the extraction of lunar differences, and for this purpose only.

180. From 1846 to 1865 the first of a day's observations was taken at 0h. 2m. of Göttingen astronomical time, or 16h. 14m. of Colába civil time; and from 1866 to 1872 at 0h. 14m. of Colába civil time.

181. The converting factors, or scale-coefficients, were calculated by the formula [equation (4) of Appendix I, paragraph (87)]

$$Xa \frac{1}{dv} \frac{dX}{X} = Xa \left\{ \cot v + \cot (A - v) \right\} \qquad (a)$$

the constants and data for insertion in which we proceed to find.

To obtain a, the value of a division of the collimator scale, the magnet and collimator were, on the 18th January 1873, firmly fixed upon the horizontal circle of a large altitude and azimuth instrument by Troughton and Simms; and the telescope of the latter instrument was fixed on a separate support so as to view the scale. The horizontal circle was then turned till the 0th, 7th, 21st and 28th divisions of the scale were successively cut by the vertical wire of the telescope, and corresponding readings were made of the horizontal circle. These gave for the value of a between 0 and 7 divisions 10′·781; between 7 and 21 divisions 10′·798, and between 21 and 28 divisions 10′·810: the mean of these—giving double weight to the middle one—is 10′·797. The arc value of a that has been adopted is *sin* 10′·80.

182. By mounting the altitude and azimuth instrument in line with the reading telescope and under the transit shutters of the room, and using it first to observe *Polaris* and then alternately with the reading telescope to read the collimator scale, it was found that the direction in which the line of collimation of the reading telescope (which had no collimation error) pointed was N. 91° 1′ 41″ W.

183. Again, mounted the altitude and azimuth instrument to northward of the horizontal force magnetometer in a position from which *Polaris* could be seen: suspended the magnet and collimator by a bunch of silk fibres, turned the mahogany enclosing box 90° in azimuth, and observed the absolute declination in the place of the horizontal force magnet to be N. 0° 55′ 25″ E. when the declination magnetometer read 36·40: also by inversions of the magnet found the scale-reading corresponding to the magnetic axis of the magnet to be 10′·90: due allowance was made for torsion of the suspension thread in the former case, and for a slight change of declination between the erect and inverted observations in the latter.

184. Repeating the experiment, with a small collimator magnet in place of the horizontal force magnet, a result was obtained which, after allowance for change of declination during the interval, was 0′ 43″ in excess of the former; and the mean of the two results was 3′ 32″ in excess of the absolute declination in the Electrometer Tower corresponding to the same reading of the declination magnetometer.

185. The several operations constituting an adjustment of the instrument, nearly as described in the Report of the Committee of Physics, pages 25 and 26, but specially as applied to the Colába instrument, are—

(1). To turn the arm of the torsion circle till the axis of the magnet is, by estimation, approximately in the magnetic meridian, with its north end directed northward.

(2). To turn the collimator in azimuth by its independent motion, till a division of the scale near the middle is cut by the reading wire of the telescope, and note the scale-reading.

(3). To remove the magnet from its socket, hang the brass weight on to the stirrup, and note the scale-reading.

(4). To turn the torsion arm so as to correct any difference in the scale-readings of (2) and (3); to repeat (2) and (3) till this is completely effected; and then to read the torsion circle.

(5). The brass weight being attached, to turn the torsion arm so as to diminish the circle reading by 90°, and then turn the collimator till a division of the scale near the middle is cut by the reading wire of the telescope, and note the scale-reading. This scale-reading and the corresponding torsion circle reading are to be called the west scale-reading and the west torsion reading respectively.

(6). Having removed the brass weight and inserted the magnet in its socket, to turn the torsion arm till the scale has the reading which it is desired to have

at the commencement of the new period of observation, and to read the torsion circle, calling the result the torsion adjustment reading.

186. Changes were made in the adjustments of the instrument at times and with results as follows :—

TABLE 73.

Date.	West torsion reading.	Adjustment torsion reading.	Angle of Torsion v_o	West scale-reading.	Remarks.
	° ′	° ′	° ′		
February 2, 1846 ...	336 38	264 17	72 21	10·85	
May 1, 1846 ...	.....	.....	.....	15·71	Collimator moved and cobweb removed.*
May 30, 1846 ...	.....	.....	.....	.....	Cobweb removed.
December 30, 1850 ...	334 58	262 37	72 21	12·20	Magnet and fittings cleaned : silver suspension wire broken and renewed.
January 25, 1853 ..	.....	.....	.....	.....	Wires brought closer together at top.
December 31, 1855 ...	.....	269 58	.....	.....	Turned torsion arm and altered distance apart of wires at top.

* The increase of scale-reading from the hour before to the hour after the change was 9·72 : in the absence of any record of the separate effects of the cobweb and of the shifting of the collimator, the half of this has been attributed to each, thus increasing the west scale-reading from 10·85 to 15·71.

187. The change of absolute declination between 1845 and 1856 being only about +6′, its effect on the value of A in the scale-coefficient formula may be neglected ; and calling the angle of torsion for which the magnetic axis of the magnet is at right angles to the magnetic meridian v_o, and writing $v_o + \Delta v$ for v, we have

$$A - v = A - v_o - \Delta v = \tfrac{\pi}{2} - \Delta v, \text{ and}$$

$$cot\,(A - v) = tan\,\Delta v, \text{ whence the formula becomes}$$

$$Xa\,\frac{1}{dv}\,\frac{dX}{X} = Xa\left\{cot\,(v_o + \Delta v) + tan\,\Delta v\right\}$$

in which, denoting the scale-reading by s,

Between May 1, 1846 and December 30, 1850.....$v_o + \Delta v = 72° 21′ + (s - 15·71)\ 10′·80$.

„ Decr. 30, 1850 and Decr. 31, 1855.....$v_o + \Delta v = 72° 21′ + (s - 12·20)\ 10′·80$.

188. At the re-adjustment of December 31, 1855, neither the west torsion reading nor the west scale-reading were re-determined ; but as the collimator was apparently not disturbed, one resource would, under the circumstances and since the change of declination was only 3′ or 4′, be to adopt the values found at the next preceding adjustment, viz. : 334° 58′ and 12·20. As the adjustment torsion reading was 269° 58′, this would give—

Between Decr. 31, 1855 and Decr. 31, 1872.....$v_o + \Delta v = 65° 0′ + (s - 12·20)\ 10′·80$.

189. But recourse may also be had to deflection experiments made in May and June 1866 and in October 1872, as means of supplying the necessary data. On the first occasion a solid cylinder magnet, 3 inches long and marked A51, was used to deflect in succession the horizontal force and declination magnetometers in the manner that has been described in paragraph 89 of Appendix I. On the later occasion the deflector magnet was substituted by a larger one marked D14 and of length 3·65 inches. The readings taken, for the several positions of the deflector magnet, were as shown in Tables 74 and 75.

TABLE 74.

Deflections of Grubb's declination magnetometer by the deflector magnets A51 and D14.

Date of Experiment.	Local Time.	Declination Magnetometer. Scale-reading.	Magnet A51. Distance in feet.	Magnet A51. North end.	Observer.	Date of Experiment.	Local Time.	Declination Magnetometer. Scale-reading.	Magnet D14. Distance in feet.	Magnet D14. North end.	Observer.
	h. m.						h. m.				
4th June 1866.	12 31	34·225	Away.	...	C. C.	2nd October 1872.	11 30	36·165	Away.	...	F. C.
	„ 40	36·595	2·0 E.	E.	C. C.		„ 32	36·165	„	...	P.
	„ 41	36·600	„	„	K.		„ 48	38·450	3·0 E.	E.	F. C.
	„ 47	31·860	2·0 E.	W.	C. C.		„ 49	38·455	„	„	P.
	„ 48	31·855	„	„	K.		„ 52	33·820	3·0 E.	W.	F. C.
	„ 53	36·590	2·0 E.	E.	C. C.		„ 53	33·820	„	„	P.
	„ 54	36·590	„	„	K.		„ 56	38·470	3·0 E.	E.	F. C.
	13 5	31·865	2·0 E.	W.	C. C.		„ 57	38·480	„	„	P.
	„ 5	31·855	„	„	K.		12 0	33·820	3·0 E.	W.	F. C.
	„ 10	36·600	2·0 E.	E.	C. C.		„ 2	33·825	„	„	P.
	„ 11	36·595	„	„	K.		„ 6	38·487	3·0 E.	E.	F. C.
	„ 13	34·240	Away.	...	C. C.		„ 7	38·490	„	„	P.
	„ 13	34·230	„	...	K.		„ 12	36·170	Away.	...	F. C.
	„ 24	35·550	2·5 E.	E.	C. C.		„ 13	36·190	„	...	P.
	„ 26	35·550	„	„	K.		„ 24	40·065	2·5 E.	E.	F. C.
	„ 28	32·945	2·5 E.	W.	C. C.		„ 26	40·060	„	„	P.
	„ 29	32·940	„	„	K.		„ 32	32·342	2·5 E.	W.	F. C.
	„ 32	35·545	2·5 E.	E.	C. C.		„ 33	32·340	„	„	P.
	„ 33	35·550	„	„	K.		„ 35	40·085	2·5 E.	E.	F. C.
	„ 34	32·945	2·5 E.	W.	C. C.		„ 37	40·092	„	„	P.
	„ 36	32·930	„	„	K.		„ 40	32·355	2·5 E.	W.	F. C.
	„ 39	35·545	2·5 E.	E.	C. C.		„ 41	32·365	„	„	P.
	„ 41	35·545	„	„	K.		„ 43	40·107	2·5 E.	E.	F. C.
	„ 45	35·025	3·0 E.	E.	C. C.		„ 44	40·110	„	„	P.
	„ 47	35·020	„	„	K.		„ 46	36·237	Away.	...	F. C.
	„ 50	33·460	3·0 E.	W.	C. C.		„ 48	36·235	„	...	P.
	„ 51	33·460	„	„	K.		„ 51	43·230	3·0 E.	E.	F. C.
	„ 54	35·030	3·0 E.	E.	C. C.		„ 52	43·230	„	„	P.
	„ 55	35·020	„	„	K.		„ 58	29·175	2·0 E.	W.	F. C.
	„ 57	33·475	3·0 E.	W.	C. C.		„ 59	29·170	„	„	P.
	„ 58	33·460	„	„	K.		13 3	43·200	2·0 E.	E.	F. C.
	14 0	35·035	3·0 E.	E.	C. C.		„ 4	43·200	„	„	P.
	„ 2	35·045	„	„	K.		„ 6	29·145	2·0 E.	W.	F. C.
	„ 4	34·255	Away.	...	C. C.		„ 7	29·150	„	„	P.
	„ 5	34·252	„	...	K.		„ 11	43·215	2·0 E.	E.	F. C.
	„ 17	34·265	„	...	K.		„ 12	43·220	„	„	P.
	„ 23	35·065	3·0 W.	E.	C. C.		„ 14	36·205	Away.	...	F. C.
	„ 25	35·085	„	„	K.		„ 16	36·205	„	...	P.
	„ 30	33·505	3·0 W.	W.	C. C.		14 28	36·455	„	...	F. C.
	„ 31	33·500	„	„	K.		„ 30	36·465	„	...	P.
	„ 33	35·092	3·0 W.	E.	C. C.		„ 34	38·850	3·0 W.	E.	F. C.
	„ 34	35·100	„	„	K.		„ 36	38·860	„	„	P.
	„ 37	33·522	3·0 W.	W.	C. C.		„ 39	34·145	3·0 W.	W.	F. C.
	„ 38	33·510	„	„	K.		„ 40	34·145	„	„	P.
	„ 40	35·102	3·0 W.	E.	C. C.		„ 43	38·855	3·0 W.	E.	F. C.
	„ 41	35·102	„	„	K.		„ 44	38·855	„	„	P.
	„ 49	35·655	2·5 W.	E.	C. C.		„ 47	34·130	3·0 W.	W.	F. C.
	„ 50	35·655	„	„	K.		„ 48	34·130	„	„	P.
	„ 54	33·035	2·5 W.	W.	C. C.		„ 50	38·847	3·0 W.	E.	F. C.
	„ 56	33·047	„	„	K.		„ 52	38·850	„	„	P.
	„ 59	35·675	2·5 W.	E.	C. C.		„ 53	36·485	Away.	...	F. C.
	15 1	35·690	„	„	K.		„ 54	36·485	„	...	P.
	„ 3	33·065	2·5 W.	W.	C. C.		„ 59	40·420	2·5 W.	E.	F. C.
	„ 4	33·075	„	„	K.		15 0	40·420	„	„	P.
	„ 7	35·707	2·5 W.	E.	C. C.		„ 3	32·575	2·5 W.	W.	F. C.
	„ 8	35·710	„	„	K.		„ 5	32·585	„	„	P.
	„ 11	34·405	Away.	...	C. C.		„ 8	40·415	2·5 W.	E.	F. C.
	„ 12	34·402	„	...	K.		„ 10	40·430	„	„	P.
	16 27	34·540	Away.	...	C. C.		„ 12	32·587	2·5 W.	W.	F. C.
	„ 32	36·940	2·0 W.	E.	C. C.		„ 13	32·585	„	„	P.
	„ 33	36·942	„	„	K.		„ 16	40·425	2·5 W.	E.	F. C.
	„ 37	32·162	2·0 W.	W.	C. C.		„ 18	40·430	„	„	P.
	„ 38	32·152	„	„	K.		„ 20	36·502	Away.	...	F. C.
	„ 44	36·952	2·0 W.	E.	C. C.		„ 21	36·500	„	...	P.
	„ 45	36·952	„	„	K.		„ 24	43·637	2·0 W.	E.	F. C.
	„ 48	32·170	2·0 W.	W.	C. C.		„ 25	43·645	„	„	P.
	„ 50	32·160	„	„	K.		„ 28	29·365	2·0 W.	W.	F. C.
	„ 54	36·957	2·0 W.	E.	C. C.		„ 30	29·380	„	„	P.
	„ 55	36·955	„	„	K.		„ 34	43·655	2·0 W.	E.	F. C.
	„ 57	34·565	Away.	...	C. C.		„ 36	43·655	„	„	P.
	„ 58	34·575	„	...	K.		„ 39	29·390	2·0 W.	W.	F. C.
							„ 40	29·390	„	„	R.
							„ 46	43·640	2·0 W.	E.	F. C.
							„ 47	43·635	„	„	P.
							„ 59	36·507	Away.	...	F. C.
							„ 52	36·505	„	...	P.

TABLE 75.

Deflections of Grubb's horizontal force magnetometer by the deflector magnets A51 and D14.

Date of experiment.	Local Time.	Horizontal force Mag. netometer — Scale-reading.	Thermometer.	Magnet A 51. Distance in feet.	Magnet A 51. North end.	Observer.	Date of experiment.	Local Time.	Horizontal force Mag. netometer — Scale-reading.	Thermometer.	Magnet D14. Distance in feet.	Magnet D14. North end.	Observer.
	d. h. m.							h. m.					
29th and 30th May 1866.	29 14 19	22·79	88·8	Away.	...	C. C. and N.	1st October 1872.	14 9	24·365	...	Away.	...	F. C.
	" " 28	25·835	88·9	2·0 N.	N.			" 10	24·355	85·9	"	...	C.
	" " 30	25·82	...	"	"			" 14	27·487	...	3·0 N.	N.	F. C.
	" " 34	19·615	88·9	2·0 N.	S.			" 15	27·480	...	"	"	C.
	" " 36	19·60	...	"	"			" 19	21·18	85·9	3·0 N.	S.	C.
	" " 40	25·71	...	2·0 N.	N.			" 20	21·17	...	"	"	F. C.
	" " 41	25·70	...	"	"			" 23	27·445	85·9	3·0 N.	N.	C.
	" " 45	19·53	89·0	2·0 N.	S.			" 24	27·44	...	"	"	F. C.
	" " 47	19·525	...	"	"			" 27	21·13	85·9	3·0 N.	S.	C.
	" " 51	25·62	...	2·0 N.	N.			" 28	21·117	...	"	"	F. C.
	" " 53	25·61	...	"	"			" 32	27·34	...	3·0 N.	N.	F. C.
	" " 55	24·18	...	2·5 N.	N.			" 34	27·34	85·9	"	"	C.
	" " 57	24·185	...	"	"			" 36	24·205	85·9	Away.	...	C.
	" 15 0	20·77	...	2·5 N.	S.			" 37	24·21	...	"	...	F. C.
	" " 2	20·775	...	"	"			" 42	18·995	85·9	2·5 N.	S.	C.
	" " 4	24·11	...	2·5 N.	N.			" 44	19·005	...	"	"	F. C.
	" " 5	24·12	...	"	"			" 50	24·277	85·9	Away.	...	F. C.
	" " 8	20·73	...	2·5 N.	S.			" 51	24·260	...	"	...	C.
	" " 9	20·725	...	"	"			" 54	19·045	...	2·5 N.	S.	F. C.
	" " 12	24·06	...	2·5 N.	N.			" 55	19·045	85·9	"	"	C.
	" " 13	24·05	...	"	"			" 58	24·280	85·9	Away.	...	C.
	" " 15	22·29	89·0	Away.	...			" 59	24·297	...	"	...	F. C.
	" " 19	22·305	...	"	...			15 4	14·69	...	2·0 N.	S.	F. C.
	" " 21	23·31	89·0	3·0 N.	N.			" 6	14·70	85·9	"	"	C.
	" " 23	23·31	...	"	"			" 9	24·265	85·9	Away.	...	C.
	" " 25	24·27	...	3·0 N.	S.			" 10	24·272	...	"	...	F. C.
	" " 26	24·255	...	"	"			" 14	14·69	85·9	2·0 N.	S.	F. C.
	" " 30	23·275	...	3·0 N.	N.			" 15	14·682	...	"	"	C.
	" " 31	23·29	...	"	"			" 19	24·255	85·8	Away.	...	C.
	" " 35	21·225	...	3·0 N.	S.			" 20	24·25	...	"	...	F. C.
	" " 37	21·225	...	"	"			" 49	24·32	86·0	"	...	C.
	" " 38	23·25	...	3·0 N.	N.			" 50	24·275	...	"	...	F. C.
	" " 39	23·24	89·1	"	"			" 53	27·467	86·0	3·0 S.	N.	F. C.
	" " 43	22·20	...	Away.	...			" 54	27·470	...	"	"	C.
	30 11 30	22·92	...	Away.	...			" 58	21·155	...	3·0 S.	S.	C.
	" " 36	26·15	...	2·0 S.	N.			" 59	21·155	...	"	"	F. C.
	" " 37	26·15	87·9	"	"			16 2	27·445	86·0	3·0 S.	N.	F. C.
	" " 42	19·75	...	2·0 S.	S.			" 3	27·440	...	"	"	C.
	" " 43	19·75	...	"	"			" 6	21·105	86·0	3·0 S.	S.	F. C.
	" " 46	26·15	...	2·0 S.	N.			" 7	21·095	...	"	"	C.
	" " 47	26·145	...	"	"			" 10	27·390	86·0	3·0 S.	N.	F. C.
	" " 50	19·745	...	2·0 S.	S.			" 11	27·395	...	"	"	C.
	" " 51	19·745	...	"	"			" 14	24·252	...	Away.	...	C.
	" " 53	26·115	...	2·0 S.	N.			" 15	24·255	86·0	"	...	F. C.
	" " 55	26·115	...	"	"			" 20	18·977	...	2·5 S.	S.	C.
	" " 58	24·70	88·3	2·5 S.	N.			" 23	18·960	85·9	"	"	F. C.
	" 12 0	24·705	...	"	"			" 26	24·225	85·9	Away.	...	F. C.
	" " 2	21·235	...	2·5 S.	S.			" 28	24·227	...	"	...	C.
	" " 4	21·24	...	"	"			" 29	18·99	85·8	2·5 S.	S.	F. C.
	" " 5	24·73	...	2·5 S.	N.			" 30	18·995	...	"	"	C.
	" " 6	24·73	...	"	"			" 32	24·250	85·8	Away.	...	F. C.
	" " 9	21·235	...	2·5 S.	S.			" 34	24·250	...	"	...	C.
	" " 9	21·24	...	"	"			" 38	14·61	85·7	2·0 S.	S.	F. C.
	" " 14	24·745	...	2·5 S.	N.			" 39	14·605	...	"	"	C.
	" " 14	24·74	...	"	"			" 41	24·240	85·7	Away.	...	F. C.
	" " 17	22·955	...	Away.	...			" 42	24·240	...	"	...	C.
	" " 49	22·91	...	"	...			" 44	14·60	85·7	2·0 S.	S.	F. C.
	" " 53	23·945	...	3·0 S.	N.			" 45	14·60	...	"	"	C.
	" " 54	23·935	88·5	"	"			" 47	24·245	...	Away.	...	C.
	" " 57	21·83	...	3·0 S.	S.			" 48	24·26	85·6	"	...	F. C.
	" " 58	21·81	...	"	"								
	" " 59	21·805	...	"	"								
	" 13 2	23·89	...	3·0 S.	N.								
	" " 4	23·895	...	"	"								
	" " 6	21·785	...	3·0 S.	S.								
	" " 7	21·80	...	"	"								
	" " 8	21·795	...	"	"								
	" " 11	23·90	...	3·0 S.	N.								
	" " 12	23·895	...	"	"								
	" " 15	22·845	88·6	Away.	...								

190. The mean deflections for the different distances, calculated from the readings of Tables 74 and 75, are as follows :—

TABLE 76.

Date.	Deflections of the declination magnetometer at distance (r).			Deflections of the horizontal force magnetometer at distance (r).			Σd.
	2·0	2·5	3·0	2·0	2·5	3·0	
1	2	3	4	5	6	7	8
May and June 1866	2·381	1·308	0·787	3·150*	1·720*	1·037*	5·907
October 1872	7·079	3·894	2·341	9·611	5·247	3·144	18·002

* In this experiment the distances were ·007 foot too great, and the deflections have been multiplied by $\left(1+\frac{3dr}{r}\right)$ to obtain those here entered. The observed deflections were 3·134, 1·714 and 1·035, and the respective factors $\left(1+\frac{\cdot021}{4}\right)$, $\left(1+\frac{\cdot021}{6\cdot25}\right)$ and $\left(1+\frac{\cdot021}{9}\right)$.

191. Using the nomenclature of paragraph 90 of Appendix I. we find the ratios $\left(\frac{d'}{d}\right)$ of these numbers to be—

TABLE 77.

r.	2·0	2·5	3·0
May and June 1866	0·7559	0·7605	0·7589
October 1872	0·7366	0·7421	0·7446

192. And now expressing the ratios in the form $\frac{d'}{d}=D\left(1+\frac{p}{r^2}\right)$, D and p being constants, we find that the first three numbers give to p an insignificant value and the last three the value $-\cdot087$. When the last three are divided by the respective values of $\left(1-\frac{\cdot087}{r^2}\right)$ the deflections (d') of Table 76 and their sums become—

TABLE 78.

r.	2·0	2·5	3·0	$\Sigma d'$	$a'\Sigma d'$	$a\Sigma d$	$\frac{a'\Sigma d}{a\Sigma d}$
1	2	3	4	5	6	7	8
May and June 1866	2·381	1·308	0·787	4·476	·0088867	·018558	·47886
October 1872	7·236	3·949	2·364	13·549	·0269002	·056557	·47563

In column 5 of this table is entered the sum of the numbers in columns 2 to 4. In column 6, $a'=6\cdot806\times1\cdot0028\times\cdot0002909$ or the arc-value of a division of the declinometer scale multiplied by the torsion coefficient. In column 7, $a=10\cdot80\times\cdot0002909$ or the arc-value of a division of the scale of the horizontal force magnetometer, and Σd is the sum of the deflections entered in columns 5 to 7 of Table 76. Column 8 shows the deduced values of $\frac{1}{dv}\frac{dX}{X}$.

193. The mean scale-reading of Grubb's declination magnetometer having been 34·50 on the first occasion and 36·34 on the second, the respective values of the easterly declination were approximately 0° 43′ 23″ and 0° 56′ 56″. With these values and the respective mean scale-readings of the horizontal force magnetometer 22·64 and 24·27, we obtain in

the manner that will be described in paragraph 196, for the magnetic deviations of the magnetic axis of the magnet N 89° 38′ 16″ W and N 89° 34′ 13″ W.

194. Inserting now numerical values in the equation (*a*) or rather in $\frac{1}{dv}\frac{dX}{X} = cot\, v + cot\,(A-v)$ we obtain for the two occasions—

$$\cdot 47886 = cot\, v + cot\,(89^\circ\, 38'\, 16'')$$ and
$$\cdot 47563 = cot\, v + cot\,(89^\circ\, 34'\, 13'')$$

whence we find $v = 64^\circ\, 42'\, 26''$ and $64^\circ\, 54'\, 51''$ on the respective occasions, when the mean scale-readings were 22·64 and 24·27 : reducing them both to the mean scale-reading 23·45—by adding and subtracting $\frac{24\cdot27-22\cdot64}{2}$ 10′·80—they become 64° 51′ 14″ and 64° 46′ 3″; or the two sets of experiments give a mean value of v for the scale-reading 23·45, of 64° 48′ 38″. For the great difference between this and 67° 1′ 30″ [= 65° 0′ 0″ + (23·45 − 12·20) 10′·80], the value found in paragraph 188, a probable reason will be given hereafter (*see* paragraph 212).

195. As the secular variation of absolute declination was much more considerable after 1856·0 than before, full account has been taken of it for the period 1856·0 to 1873·0 in calculating values of the angle $(A-v)$. For the present purpose the yearly values of the absolute easterly declination were obtained from the mean scale-readings (f) of Grubb's declination magnetometer, by means of the formulæ

from 1856 to 1860..... $\delta = (f - 28\cdot3064)\ 6\cdot806 \times 1\cdot003009$ and
from 1862 to 1872..... $\delta = (f - 28\cdot2733)\ 6\cdot806 \times 1\cdot0028$

the mean of the values for 1860 and 1862 being interpolated as that for 1861.

196. Values of $(A-v)$ were then obtained, for the months January to June 1856 and for each year or half-year thereafter, by adding the absolute easterly declination to 91° 1′ 41″, the westward azimuth of the line of collimation of the reading telescope, and deducting (s—10·90) 10′·80, the deviation of the north end of the axis of the magnet to northward of the line of view of the telescope. These values and the data used in the calculations are shown in Table 79 :—

TABLE 79.

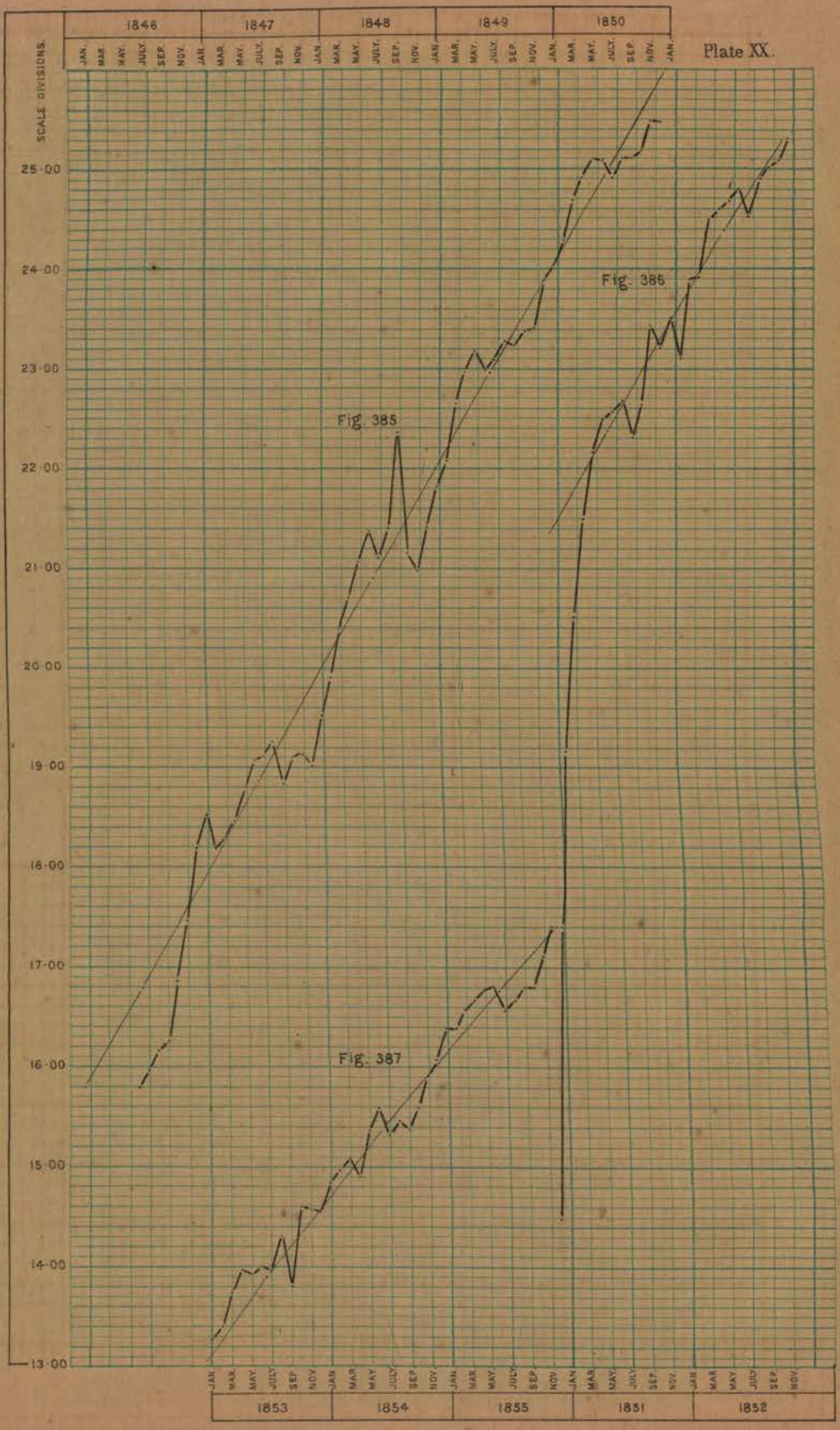
Year.	Absolute easterly declination. δ	Mean scale-reading of Grubb's horizontal force Magnetometer. s.	91° 1′ 41″ + δ − (s − 10·90) 10′·80. $A-v$.
	′ ″		° ′ ″
1856¼	19 12	18·31	89 59 15
1856½	19 14	19·18	89 51 23
1856¾	19 15	19·05	89 52 48
1856¼	19 17	19·08	89 52 31
1856⅝	19 19	19·18	89 51 28
1856¾	19 20	18·86	89 54 56
1856·5	19 21	18·89	89 54 44
1857·5	19 41	18·97	89 54 13
1858·5	20 14	18·63	89 58 26
1859·5	21 54	19·08	89 55 14
1860·5	24 24	19·60	89 52 7
1861·5	27 23	20·29	89 47 39
1862·5	30 23	20·69	89 46 20
1863·5	33 48	21·24	89 43 49
1864·5	36 17	21·75	89 40 47
1865·5	39 52	22·46	89 36 42
1866·5	43 55	23·00	89 34 55
1867·5	46 28	23·54	89 31 38
1868·5	48 56	23·92	89 30 0
1869·5	50 40	24·00	89 30 52
1870·5	52 58	24·36	89 29 17
1871·5	54 56	24·79	89 26 36
1872·5	56 20	25·05	89 25 12

197. We now proceed to determine yearly values of X, the horizontal force, using for the purpose the mean monthly scale-readings of Grubb's horizontal force magnetometer

COLABA OBSERVATORY.

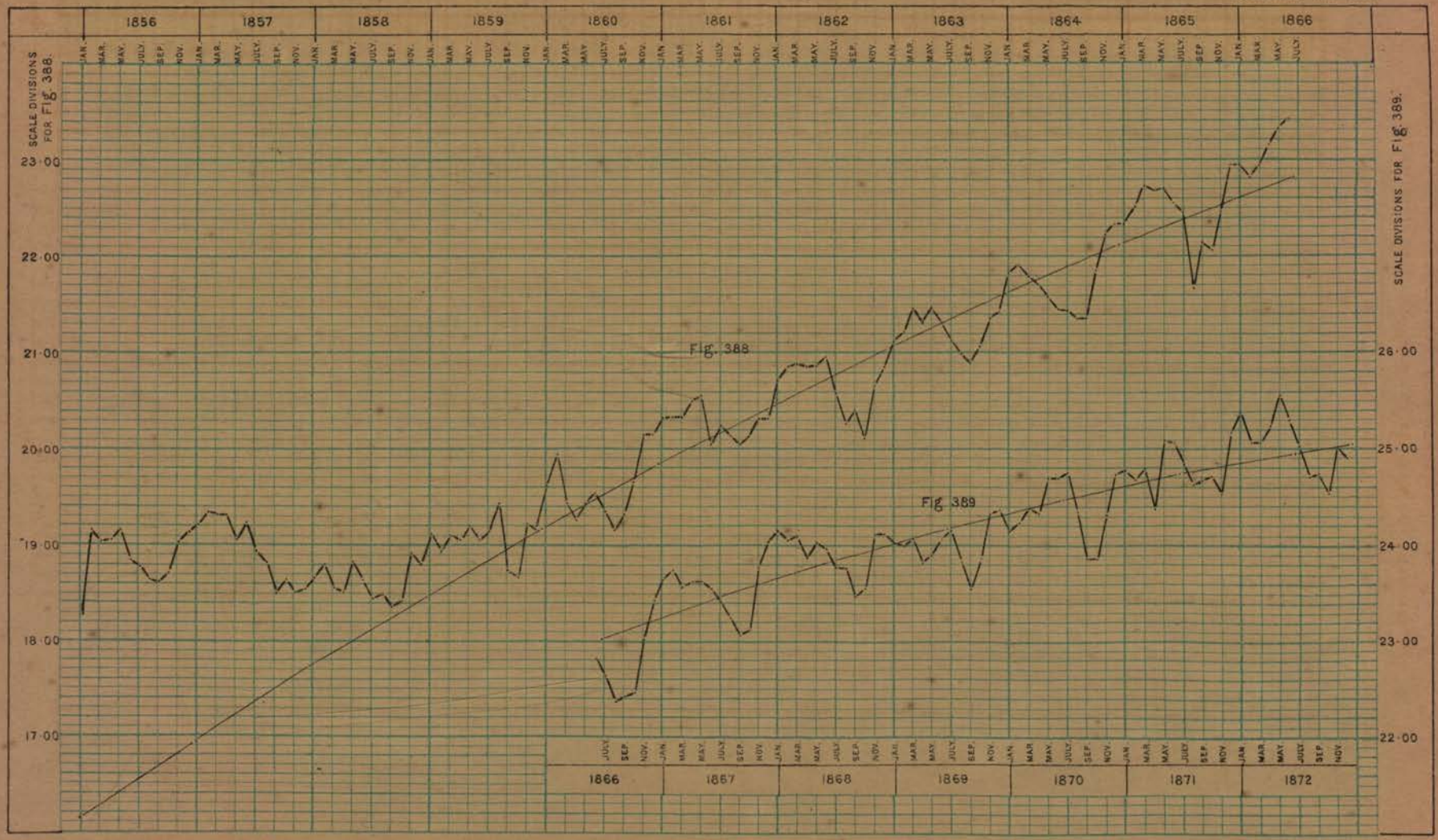
MEAN SCALE READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER.

Plate XX.



MEAN SCALE READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER.

Plate XX. *Continued*



corrected for temperature at the rate of 0·22* sc. div. *per* degree Faht. from 1846·42 to 1856·0 and at the rate of 0·15 sc. div. *per* degree from 1856·0 to 1873·0, the observed readings being increased for temperatures above 82° and decreased for temperatures below 82°. On account of repeated interruptions and abnormal behaviour of the instrument between January and May 1846 no use will be made of the mean readings before June 1846. The corrected monthly means from June 1846 to December 1872 are shown in Table 80, and dividing them into five periods 1846·42 to 1851·0, 1851·0 to 1853·0, 1853·0 to 1856·0, 1856·0 to 1866·5 and 1866·5 to 1873·0, they are separately curved, with time as abscissæ and corrected scale-readings as ordinates, in Figs. 385 to 389 (Plate XX).

TABLE 80.

Monthly mean scale-readings of Grubb's horizontal force magnetometer, corrected to temperature 82° Faht.

YEAR.	January	Feby.	March.	April.	May.	June.	July.	August.	Septr.	October.	Novr.	Decr.
1846	...	...	...	...	...	15·76	15·93	16·12	16·23	16·83	17·42	18·17
1847	18·50	18·16	18·27	18·43	18·77	19·04	19·09	19·22	18·80	19·07	19·11	18·99
1848	19·50	19·89	20·35	20·69	21·04	21·36	21·08	21·39	22·32	21·11	20·93	21·39
1849	21·79	22·06	22·61	22·92	23·15	22·95	23·05	23·23	23·20	23·34	23·39	23·85
1850	23·98	24·25	24·66	24·89	25·07	25·05	24·87	25·07	25·07	25·14	25·46	25·42
1850	...	...	...	...	...	...	...	...	...	...	...	14·42
1851	17·37	19·11	20·48	21·46	22·11	22·45	22·53	22·63	22·27	22·60	23·40	23·19
1852	23·47	23·06	23·85	23·87	24·44	24·56	24·63	24·77	24·48	24·86	24·99	25·04
1853	25·27	...	...	...	...	...	...	...	...	...	...	...
1853	13·23	13·38	13·70	13·93	13·89	13·98	13·92	14·28	13·77	14·57	14·54	14·51
1854	14·80	14·92	15·05	14·86	15·32	15·57	15·29	15·41	15·33	15·57	15·88	16·03
1855	16·36	16·34	16·54	16·62	16·73	16·79	16·53	16·63	16·78	16·77	17·09	17·39
1856	18·31	19·18	19·05	19·08	19·18	18·86	18·80	18·66	18·63	18·72	19·04	19·16
1857	19·21	19·36	19·33	19·33	19·08	19·26	18·95	18·84	18·51	18·66	18·52	18·56
1858	18·68	18·81	18·58	18·51	18·85	18·65	18·46	18·50	18·38	18·42	18·94	18·81
1859	19·14	18·96	19·11	19·08	19·21	19·05	19·16	19·44	18·76	18·68	19·22	19·19
1860	19·62	19·95	19·45	19·27	19·44	19·56	19·37	19·17	19·34	19·68	20·17	20·18
1861	20·34	20·35	20·35	20·51	20·58	20·05	20·26	20·15	20·05	20·14	20·33	20·33
1862	20·71	20·88	20·90	20·88	20·89	20·99	20·60	20·29	20·42	20·12	20·69	20·87
1863	21·11	21·23	21·49	21·33	21·49	21·32	21·14	21·00	20·90	21·09	21·38	21·43
1864	21·84	21·91	21·80	21·71	21·60	21·46	21·44	21·38	21·39	21·88	22·24	22·36
1865	22·35	22·54	22·75	22·70	22·73	22·58	22·47	21·69	22·16	22·07	22·48	22·97
1866	22·97	22·82	22·95	23·17	23·32	23·43	...	...	...	...	...	...
1866	...	...	...	...	...	22·81	22·64	22·38	22·41	22·47	23·02	23·43
1867	23·65	23·75	23·58	23·63	23·63	23·56	23·41	23·25	23·08	23·13	23·79	24·03
1868	24·17	24·07	24·10	23·88	24·02	23·99	23·79	23·77	23·47	23·57	24·12	24·14
1869	24·03	24·00	24·07	23·81	23·90	24·08	24·16	23·81	23·55	23·87	24·32	24·38
1870	24·15	24·22	24·39	24·32	24·70	24·70	24·76	24·35	23·87	23·87	24·31	24·74
1871	24·79	24·69	24·80	24·39	25·10	25·07	24·84	24·63	24·68	24·72	24·54	25·19
1872	25·40	25·09	25·08	25·24	25·58	25·30	25·01	24·70	24·74	24·54	25·01	24·90

198. If in Figs. 385 to 389 we disregard the oscillations which are evidently representations of the annual variation of the horizontal force, and disregard also the early parts of Figs. 386 and 388, which follow fresh adjustments of the instrument, a mere inspection shows that there is a general increase of scale-reading from first to last, that the increase is at a nearly uniform rate till 1853·0, and that it is thenceforward at a gradually diminishing rate till 1873·0. Assuming, for the present, that the increase of scale-reading is due solely to increase of force, we select the periods of steady increase 1847·0 to 1851·0, 1851·5 to 1853·0, 1853·0 to 1856·0, 1859·5 to 1866·5, and 1867·0 to 1873·0, and finding the annual increments of scale-reading to be 2·04, 2·02, 1·37, 0·57 and 0·30 respectively, attribute them to the mean epochs 1849·0, 1852·25, 1854·5, 1863·0 and 1870·0, for which the mean scale-readings are 21·90, 23·84, 15·34, 21·02 and 24·28 respectively. The mean scale-readings from which these numbers are derived are shown in Table 81.

* As stated in paragraph 176 the rates used in the final reduction of the observations were 0·20 and 0·21 sc. div., the value 0·22 was deduced from that found (·1506) for the period 1856 to 1865, and was used, provisionally, for this investigation only.

TABLE 81.

Middle of Year.	Mean scale-reading.	Middle of Year.	Mean scale-reading.	Middle of Year.	Mean scale-reading.	Middle of Year.	Mean scale-reading.	Middle of Year.	Mean scale-reading.
1847·5 ...	18·79	1852·0 ...	23·32	1853·5 ...	13·97	1860·0 ...	19·31	1867·5 ...	23·54
1848·5 ...	20·92	1852·25 ...	23·86	1854·5 ...	15·34	1861·0 ...	20·01	1868·5 ...	23·92
1849·5 ...	22·96	1852·5 ...	24·33	1855·5 ...	16·71	1862·0 ...	20·54	1869·5 ...	24·00
1850·5 ...	24·91					1863·0 ...	20·91	1870·5 ...	24·36
						1864·0 ...	21·44	1871·5 ...	24·79
						1865·0 ...	22·19	1872·5 ...	25·05
						1866·0 ...	22·71		

199. With the above-mentioned mean scale-readings for the several epochs and with the data of Table 73, we obtain, by equation (*h*)

For 1849·0... $\frac{a}{dv}\frac{dX}{X} = sin\,10'{\cdot}80\left[cot\{72°21' + (21{\cdot}90 - 15{\cdot}71)10'{\cdot}80\} + tan(21{\cdot}90 - 15{\cdot}71)10'{\cdot}80\right] = {\cdot}0009941$*

for 1852·25... $\frac{a}{dv}\frac{dX}{X} = sin\,10'{\cdot}80\left[cot\{72°21' + (23{\cdot}84 - 12{\cdot}20)10'{\cdot}80\} + tan(23{\cdot}84 - 12{\cdot}20)10'{\cdot}80\right] = {\cdot}0009894$

& for 1854·5... $\frac{a}{dv}\frac{dX}{X} = sin\,10'{\cdot}80\left[cot\{72°21' + (15{\cdot}34 - 12{\cdot}20)10'{\cdot}80\} + tan(15{\cdot}34 - 12{\cdot}20)10'{\cdot}80\right] = {\cdot}0009966$

and by equation (*a*), assuming, for the present, that the scale-reading 23·45 corresponds to the angle of torsion 65° 1′ 22″, and taking (*A*−*v*) by interpolation from Table 79,

for 1863·0... $\frac{a}{dv}\frac{dX}{X} = sin\,10'{\cdot}80\left[cot\{65°\,1'\,22'' + (21{\cdot}02 - 23{\cdot}45)\,10'{\cdot}80\} + cot(89°\,45'\,5'')\right] = {\cdot}0015064$

and for 1870·0... $\frac{a}{dv}\frac{dX}{X} = sin\,10'{\cdot}80\left[cot\{65°\,1'\,22'' + (24{\cdot}28 - 23{\cdot}45)\,10'{\cdot}80\} + cot(89°\,30'\,5'')\right] = {\cdot}0014808$

200. Attributing, for the moment, the several annual increments of scale-reading, taken in order, to the periods 1846·0 to 1851·0, 1851·0 to 1853·0, 1853·0 to 1856·0, 1856·0 to 1866·5 and 1866·5 to 1873·0, and applying the values of $\frac{a}{dv}\frac{dX}{X}$ just found to the respective periods, we find for the increments of force between the several epochs:

From 1849·0 to 1852·25 ... 2 ×2·04×·0009941+1·25×2·02×·0009894 = ·006554
„ 1852·25 to 1854·5 ... 0·75×2·02×·0009894+1·5 ×1·37×·0009966 = ·003547
„ 1854·5 to 1863·0 ... 1·5 ×1·37×·0009966+ 7 ×0·57×·0015064 = ·008058
„ 1863·0 to 1870·0 ... 3·5 ×0·57×·0015064+3·5 ×0·30×·0014808 = ·004560

201. Or taking the horizontal force of 1870·0 as unity, and subtracting these increments in turn, its values at the several epochs are approximately—

At 1849·0 ... ... 0·977281
„ 1852·25... ... ... 0·983835
„ 1854·5 ... ... 0·987382
„ 1863·0 ... ... 0·995440
„ 1870·0 ... ... 1·000000

202. And multiplying the several values of $\frac{a}{dv}\frac{dX}{X}$ by these numbers, taken in order, the products are approximate values of the scale coefficient on the supposition that the force of the epoch 1870·0 is expressed by unity.

203. Using these values in lieu of those of paragraph 199, and repeating the calculations of paragraphs 200 to 202, we obtain further approximations as follows :—

TABLE 82.

At Epoch.	Horizontal Force.	Scale-coefficient.	Scale-coefficient adopted.†	Periods to which the coefficient may be taken as applicable.
	In terms of the Horizontal Force at the epoch 1870·0.			
1849·0 ...	0·977529	·0009718	·0009702	1846·0 to 1851·0
1852·25 ...	0·983951	·0009735	·0009720	1851·0 to 1853·0
1854·5 ...	0·987448	·0009841	·0009827	1853·0 to 1856·0
1863·0 ...	0·995453	·0014996	·0014996	1856·0 to 1866·5
1870·0 ...	1·000000	·0014808	·0014808	1866·5 to 1873·0

* This is too great by an insignificant number of 3 in the last place of decimals: it is the mean of two results for the scale-readings 10·85 and 20·57, and has been used instead of the single result for the mean scale-reading 15·71.

† In the calculation of these values the periods for which uniform rates of increase of horizontal force were assumed were from epoch to epoch, not those stated in paragraph 200. The results are, however, practically identical.

Further repetition of the calculations, it may be remarked, produces no further alteration of the resulting numbers.

204. Our assumption of a uniform rate of change during each period having now served its purpose, we shall—in what follows—regard the annual increments as representing the rate of change for the mean epochs of the several periods only, and we shall now assume that the rate grows uniformly from epoch to epoch. Converting the preceding and following rates, of 1863·0 for example, into the same scale as its own, by multiplying them by the respective scale-coefficients of Table 82 and dividing the products by that of 1863·0, we obtain for the times 1854·5, 1863·0 and 1870·0 the rates +0·898, +0·57 and +0·296 scale-divisions respectively, showing a growth *per* year of $-\frac{\cdot 328}{8\cdot 5}$ for 1854·5 to 1863·0 and $-\frac{\cdot 274}{7}$ for 1863·0 to 1870·0. Thus for a time $+T$ reckoned in years onward from 1863·0 we have for the increase of scale-reading

$$+ 0\cdot 57\ T - \tfrac{1}{2}\tfrac{\cdot 274}{7} T^2$$

and, for a time $-T$ reckoned backward from 1863·0

$$-0\cdot 57\ T - \tfrac{1}{2}\tfrac{\cdot 328}{8\cdot 5} T^2$$

In this way we find increments of scale-reading as follows :—

TABLE 83.

Time.	Increment.	Scale-reading — observed.	Deduced scale-reading for 1863.
1860·0 ...	− 1·88	19·31	21·19
1861·0 ...	− 1·22	20·01	21·23
1862·0 ...	− 0·59	20·54	21·13
1863·0 ...	0·00	20·91	20·91
1864·0 ...	+ 0·55	21·44	20·89
1865·0 ...	+ 1·06	22·19	21·13
1866·0 ...	+ 1·53	22·71	21·18

The mean of the numbers in the last column, giving (by mistake) double weight to the value for the epoch 1863·0, is 21·07. Adding this to the respective increments we obtain what we shall call the calculated scale-reading for the several times; and in the same way, and with the same data, calculated scale readings are found for the remainder of the period 1856·0 to 1866·5.

205. By a similar treatment of the data of the other periods, but using the same growth of the rate of increase before as immediately after 1849·0, and the same after as immediately before 1870·0, calculated scale-readings were obtained for the periods 1846·0 to 1851·0, 1851·0 to 1853·0, 1853·0 to 1856·0 and 1866·5 to 1873·0 : these are shown in Table 84, and it is from them that the smooth-flowing curves of Figs. 385 to 389 have been constructed :—

TABLE 84.

Year.	Calculated scale-reading.	Year.	Calculated scale-reading.	Year.	Calculated scale-reading.	Year.	Calculated scale-reading.	Year.	Calculated scale-reading.
1846·0 ...	15·76	1851·0...	21·31	1853·0...	13·01	1856·0...	16·13	1866·5...	23·04
1846·5 ...	16·78	1851·5...	22·32	1853·5...	13·87	1857·0...	16·96	1867·5...	23·46
1847·5 ...	18·83	1852·0...	23·33	1854·5...	15·38	1858·0..	17·74	1868·5...	23·84
1848·5 ...	20·88	1852·5...	24·34	1855·5...	16·72	1859·0...	18·48	1869·5...	24·18
1849·5 ...	22·92	1853·0...	25·28	1856·0...	17·37	1860·0...	19·19	1870·5...	24·48
1850·5 ...	24·95					1861·0...	19·85	1871·5...	24·74
1851·0 ...	25·97					1862·0...	20·48	1872·5...	24·96
						1863·0...	21·07	1873·0...	25·05
						1864·0...	21·62		
						1865·0...	22·13		
						1866·0...	22·60		
						1866·5...	22·82		

206. In Figs. 385 to 389 the agreement of the curves of calculated scale-readings with the general course of the curves of observed scale-readings is satisfactory, except for a while after any manipulation of the suspension wire that alters temporarily or permanently the amount of twist in it, and especially after the re-adjustments of February 2,1846 ; December 30, 1850, and December 31, 1855. To explain the cause of the discrepancies at

these times we must introduce a neglected element, the torsion of each branch of the suspension wire about itself, into the theory of the instrument. Calling the moment of torsion *per* unit angle τ, our fundamental equation (1), of paragraph 87 (Appendix I), becomes

$$m\,X\,sin\,(A-v) = W_g \frac{aa'}{l}\,sin\,v + 2\tau\,(v-w) \qquad (1a)$$

where w* may be regarded as constant during the short periods for which variations of X and v are considered, but as variable in much longer periods.

Hence dA being negligible,

$$sin\,(A-v)\,d\,(mX) - mX\,cos\,(A-v)\,dv = \left(W_g \frac{aa'}{l}\,cos\,v + 2\tau\right) dv \qquad (2a)$$

$$\frac{1}{dv}\frac{d\,(mX)}{(mX)} = cot\,(A-v) + \frac{W_g \frac{aa'}{l}\,cos\,v + 2\tau}{W_g \frac{aa'}{l}\,sin\,v + 2\tau\,(v-w)}$$

$$\frac{1}{dv}\frac{d(mX)}{(mX)} = cot\,(A-v) + \frac{W_g \frac{aa'}{l}\,cos\,v}{W_g \frac{aa'}{l}\,sin\,v}\,\frac{1+\frac{2\tau}{W_g \frac{aa'}{l}\,cos\,v}}{1+\frac{2\tau(v-w)}{W_g \frac{aa'}{l}\,sin\,v}}$$

and, regarding the second terms of the numerator and denominator of the last fraction as small in comparison with unity,

$$\frac{1}{dv}\frac{d(mX)}{(mX)} = cot\,(A-v) + cot\,v\left\{1 + \frac{2\tau}{W_g \frac{aa'}{l}\,cos\,v} - \frac{2\tau\,(v-w)}{W_g \frac{aa'}{l}\,sin\,v}\right\} \qquad (3a)$$

Now τ may be found by suspending the horizontal force magnet by a single silver wire of the same kind as is used in the magnetometer and of the same length as one of its branches, and observing the deviation (u) of the magnet from the meridian when an angle of torsion ($U-u$) is introduced into the wire: for we shall have $\tau\,(U-u) = mXu$ or $\tau = mX\frac{u}{U-u}$. Substituting, also, in the last two terms of equation (3a) the near equivalent mX for $W_g \frac{aa'}{l}\,sin\,v$, the equation becomes

$$\frac{1}{dv}\frac{d(mX)}{(mX)} = cot\,(A-v) + cot\,v + \frac{2u}{U-u} - cot\,v\,\frac{2\tau\,(v-w)}{mX} \qquad (4a)$$

Comparing this with equation 4, of paragraph 87 (Appendix I), we note that it contains one additional term which is constant and one which varies as the torsion $2\tau\,(v-w)$.

207. We remark now that if at the end of operation (4) of paragraph 185 there be no torsion in the suspension wire, both branches of it will lie wholly in the magnetic meridian, and that at the conclusion of the adjustment the torsion will be v or that $w=0$. We conceive, however, that the wire—being under the tension of a weight, in this case, of 8285 grains—will, with the lapse of time, gradually lose its torsion, and that a while after the adjustment it may be assumed to be sensibly free from it, that is $w=v$: meanwhile, we see from equation (1a) that without any change of mX, as $(v-w)$ diminishes, v increases, and in such a way that the decrease of $2\tau(v-w)$ is sensibly balanced by the increase of $W_g \frac{aa'}{l}\,sin\,v$. But, if some years after—the adjustment remaining the same until then—the operation (4) be repeated, it will be found at the end of it that the wires are no longer wholly in the meridian plane: the bottom ends of the wires will be in that plane, but the vertical plane containing the top ends will be inclined to the meridian; and if the torsion arm be now turned back to its former adjustment reading the value found for the angle A will differ from its former value by the angle of inclination of the two planes, although there is no real change in the adjustment. Consequently v or $\left(A-\frac{\pi}{2}\right)$ will also differ by the same amount from its former and correct value.

208. We have the following evidence that what is stated above really occurs. We premise that the readings of the torsion circle increase by a right-handed rotation of the torsion arm. Before April 1845, the north end of the magnet had always been turned

* If there be any torsion in the wires when the plane containing them at the bottom ends is the magnetic meridian w must, of course, include it.

eastward: it was then turned westward, and the meridian torsion reading found was 68° 28′: at the adjustment in February 1846 the meridian reading was found to have fallen to 66° 38′ or by 1° 50′: this consists with the fact that a relative left-handed twist (looking from above) that was put into the wire on the first occasion partly disappeared, by molecular change of the wire, before the second. Whether any part of the twist remained or an opposite one had been acquired we cannot now ascertain, and in adopting for the magnetic west torsion reading 336° 38′, we virtually assume that there was no twist in the wire when the meridian torsion reading was observed on the latter occasion. Again, with a fresh wire that may be presumed to have been approximately free from torsion on its first attachment, there was after the adjustment in December 1850, a rapid rise of the scale-readings which was far in excess of the effects of any real increase of mX: the rapid increase of v that this implies is such as would follow upon the gradual disappearance of the left-handed torsion put into the wire at the time of the adjustment. And further, when the instrument was first examined before readjustment in January 1873, there was a decided right-handed twist in the wire when the plane of the wires at bottom was turned into the meridian, and so persistent was it that after a weight instead of the magnet, had been hanging from the wire for four days, it was still from 2° to 3° in amount, though gradually diminishing.

209. Reverting now to equation (4*a*) let us imagine another instrument like the one under consideration in all respects and under the same circumstances except that $(v-w)$ is always *zero*, and let it be subject to the same changes of mX. For distinction sake let us call the v of this instrument V. Then, in lieu of (4*a*) we shall have

$$\frac{1}{dV}\frac{d(mX)}{(mX)} = \cot(A-V)+\cot V+\frac{2u}{U-u} \qquad (4b)$$

But, as the left-hand sides of equations (4*a*) and (4*b*) are equal, the right-hand sides will also be equal; and if we can find the values of V that correspond to those of v, we may use equation (4*b*) in lieu of (4*a*). This is, however, precisely what we suppose the curves of calculated scale-readings of Figs. 385 to 389 enable us to do: we take them to represent the course of variation of the scale-readings that would have been run if the wires had, throughout each period, been free from torsion, as they have been very nearly in the later years of each period: otherwise stated, we regard the departures, in the positive direction, of the general course of the observed scale-readings from that of the calculated scale-readings as measuring the excess of v over V.

210. Using the calculated scale-readings in this sense, let us now compare the changes that they give with the changes indicated by available direct determinations of absolute horizontal force. Of the latter we have a mean value in British units for May to December 1846* (7·887), and a mean value for the year 1863† (8·0794), both obtained from observations with the same old unifilar magnetometer; and we have also mean values for the years 1868‡ (8·0563) and 1872‡ (8·0728) both obtained from observations with Elliott's unifilar magnetometer, and reduced to the monthly mean reading of Grubb's horizontal force magnetometer. Premising that the annual inequalities for the months May to December are less than one in the third place of decimals and therefore negligible, we must subtract ·0026, two months' secular change from 7·887 to reduce it to the middle of the year 1846: we then have increases of 8·0794−7·8844=+·1950 from 1846·5 to 1863·5 and of 8·0728−8·0563=+·0165 from 1868·5 to 1872·5. To compare with these increments we have from the calculated scale-readings,

From 1846·5 to 1851·0 ... ... (25·97−16·78) × ·0009702=·008916
„ 1851·0 to 1853·0 ... ... (25·28−21·31) × ·0009720=·003859
„ 1853·0 to 1856·0 ... ... (17·37−13·01) × ·0009827=·004285
„ 1856·0 to 1863·5 ... ... (21·34−16·13) × ·0014996=·007813
Total increase from 1846·5 to 1863·5 ... ... =·024873
Do. do. , in British units of force, =+·024873 × 8·0581§=+·2004 and . . . . . .
From 1868·5 to 1872·5 ... ... (24·96−23·84) × ·0014808=·001658 or in British units=+·0134.

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* See "Bombay Magnetical and Meteorological Observations, 1845," Results, page (32).
† Do. do. do. 1863," Introduction, page ix.
‡ See Philosophical Transactions, Vol. 166, page 84.
§ This is the value of the horizontal force that we have adopted for the epoch 1870·0: it is the mean result given by the absolute observations for the months of December 1869 and January 1870.

These increments differ but slightly from the corresponding increments given by the absolute determinations, and so inconsiderable is the difference between the aggregates of the former and of the latter increments—being only about a three ten thousandth of the horizontal force—that the two sets of numbers may be taken to imply that the strength of the magnet of the horizontal force magnetometer has been practically constant throughout the period of twenty-six and a half years, and to justify therefore the provisional assumption made in paragraph 198 that—except as regards changes of the torsion of the wire—the increase of scale-reading is due solely to increase of the horizontal force.

211. Having arrived at this result, we may—with the scale-coefficients of paragraph 203 applied for their respective periods,—deduce from the calculated scale-readings of succeeding years (or half years) the changes of force from year to year (or half year) in terms of the horizontal force at the epoch 1870: then, calling this latter unity and subtracting from it the change from 1869·5 to 1870·0 we get the force for 1869·5; from this subtracting the change from 1868·5 to 1867·5 we get the force for 1867·5; and so on. In this way have been obtained the numbers in column 2 of Table 85. Finally these numbers have been multiplied by 8·0581 and by 0·46108 to obtain values of X for insertion in equation (b).

212. Now, comparing equations ($4b$) and (a) we are prepared to understand why the angle v* deduced (in paragraph 194) from deflection experiments is so much less than the value inferred from previous direct measurements. In equating the observed values of $\frac{1}{dv}\frac{dX}{X}$ to $cot\ v + cot\ (A - v)$ instead of to $cot\ v + \frac{2u}{U-u} + cot\ (A - v)$, the apparent value of $cot\ v$ that we obtained was really the value of $cot\ v + \frac{2u}{U-u}$; and the difference between the apparent and real values may be taken as a rough measure of $\frac{2u}{U-u}$. This difference is approximately ($cot\ 64°\ 48'\ 38'' - cot\ 67°\ 1'\ 30''$) = ·0464, whence $\frac{u}{U-u}$ = ·0232, or about one-fourth of the value (·0894) found experimentally with a similar magnet and suspension wire in 1855. [See Bombay Magnetical and Meteorological Observations, 1855, Introduction, page viii]. There can be no doubt that the result of the deflection method, which measures the actual coefficient of the time of the experiments, whatever this may depend upon, is to be preferred to the other in any case, though more so because the latter is derived from uncertain data; and although it would be desirable to separate the two parts of the result—$cot\ v$ and $\frac{2u}{U-u}$—if we had accurate and dependable experimental measures of the latter part, we have decided, in the absence of such measures, to regard the result as including the constant $\frac{2u}{U-u}$. It is quite conceivable that after long use of the instrument the wires having been subjected to a great number of small increments and decrements of the twist, a different value would be found of $\frac{2u}{U-u}$ from the one that was determined for the same wire before it was first put in use; so that even an experimental value may not safely be regarded as an absolute constant, and a guessed value would be even more objectionable. Under the circumstances we regard it as impracticable to make any allowance for the term $\frac{u}{U-u}$ in the value of the scale-coefficient for the period before 1856·0: and, accordingly, the general practice of magneticians will be followed in the conversion of variations derived from the observations of 1847 to 1855 from scale-readings into magnetic force.

213. Unfortunately the investigation which had led to the equation ($4b$) was not worked out upon paper before the scale-coefficients were calculated and actually applied, and in the mental impression of it acted upon, the first term of the equation had the angle v in the place that should have been occupied by V. This involves sensible errors in the coefficients of the years 1856 and 1857 but only insignificant errors for other years. A small error is also involved in the use of a slightly different value of $cot\ V + \frac{2u}{U-u}$ from

* As there was no torsion in the wire at the time of the experiments (1866 and 1872) the angles v and V may be written indiscriminately.

that found above. To estimate the amount of the errors, we have—writing $cot\ V'$ for $cot\ V + \frac{2u}{U-u}$, and V'' for the erroneous value of V' made use of—

$$\frac{1}{dv}\frac{dX}{X} = cot\ V' + cot\ (A-V)$$

$$= cot\left\{V''-(V''-V')\right\} + cot\left\{(A-v)+(v-V)\right\}$$

$$= cot\ V'' + \frac{(V''-V')}{sin^2 V''} + cot\ (A-v) - (v-V), \text{ since } (A-v) = \frac{\pi}{2} \text{ nearly, and} \quad (4c)$$

$$Xa\frac{1}{dv}\frac{dX}{X} = Xa\left\{cot\ V'' + cot\ (A-v) + \frac{V''-V'}{sin^2 V''} - (v-V)\right\} \quad (4d)$$

or inserting adopted standard values,

$$= Xa\left[cot\left\{65°\ 1'\ 22'' + (S-23\cdot45)\ 10'\cdot80\right\} + cot\left\{91°\ 1'\ 41'' + s - (s-10\cdot90)\ 10'\cdot80\right\}\right.$$

$$\left. + Xa\left[\frac{sin(65°\ 1'\ 22''-64°\ 48'\ 38'')}{sin^2\{65°\ 1'\ 22'' + (S-23\cdot45)\ 10'\cdot80\}} - (s-S)\ 10\cdot80\ sin\ 1'\right]\right. \quad (4e)$$

where s represents the mean observed and S the calculated scale-reading.

214. The values of the two terms of this expression have been calculated separately, for each month from January to June 1856, and for each year or half year from 1856·0 to 1873·0, and the values of the first term are entered in column 7 of the following table, as the adopted coefficients, and the values of the second term in column 8, as errors (or algebraical *defects*) of the adopted coefficients: the data for each calculation are also shown in the table.

TABLE 85.*

Date.	$\frac{X}{3\cdot7154}$	s.	S.	V''.	$A-v$.	Adopted scale-coefficient.	Error of adopted scale-coefficient.
1	2	3	4	5	6	7	8
				° ′ ″	° ′ ″		
1856½ ...	·98810	18·31	[16·16]	[63 42 39]	89 59 15	·00569	− ·00003
1856¾ ...	·98820	19·18	[16·23]	[63 43 25]	89 51 23	·00572	− ·00005
1856⅝ ...	·98830	19·05	[16·30]	[63 44 10]	89 52 48	·00572	− ·00005
1856¾ ...	·98841	19·08	[16·37]	[63 44 54]	89 52 31	·00572	− ·00005
1856⅞ ...	·98851	19·18	[16·44]	[63 45 39]	89 51 28	·00572	− ·00005
1856½ ...	·98861	18·86	[16·51]	[63 46 24]	89 54 56	·00570	− ·00003
1856·5 ...	·98868	18·89	[16·56]	63 46 57	89 54 44	·00570	− ·00003
1857·0 ...	·98928	[18·93]	16·96	63 51 16	.....	·00569	− ·00002
1857·5 ...	...	18·97	...	.....	89 54 13	[·00567]	[·00000]
1858·0 ...	·99045	[18·80]	17·74	63 59 42	.....	·00565	+ ·00001
1858·5 ...	...	18·63	...	.....	89 58 26	[·00563]	[+·00002]
1859·0 ...	·99156	[18·85]	18·48	64 7 41	.....	·00562	+ ·00004
1859·5 ...	...	19·08	...	.....	89 55 14	[·00561]	[+·00004]
1860·0 ...	·99265	[19·34]	19·19	64 15 22	.....	·00561	+ ·00005
1860·5 ...	...	19·60	...	.....	89 52 7	[·00561]	[+·00005]
1861·0 ...	·99362	[19·94]	19·85	64 22 29	.....	·00560	+ ·00005
1861·5 ...	...	20·29	...	.....	89 47 39	[·00559]	[+·00005]
1862·0 ...	·99456	[20·49]	20·48	64 29 17	.....	·00558	+ ·00005
1862·5 ...	...	20·69	...	.....	89 46 20	[·00557]	+ ·00005]
1863·0 ...	·99544	[20·96]	21·07	64 35 40	.....	·00557	+ ·00006
1863·5 ...	...	21·24	...	.....	89 43 49	[·00556]	[+·00006]
1864·0 ...	·99627	[21·49]	21·62	64 41 36	.....	·00556	+ ·00006
1864·5 ...	...	21·75	...	.....	89 40 47	[·00555]	[+·00005]
1865·0 ...	·99704	[22·10]	22·13	64 47 7	.....	·00555	+ ·00005
1865·5 ...	...	22·46	...	.....	89 36 42	[·00554]	[+·00005]
1866·0 ...	·99775	[22·73]	22·60	64 52 11	.....	·00553	+ ·00005
1866·5 ...	·99809	23·00	23·04	64 56 56	89 34 55	·00553	+ ·00005
1867·5 ...	·99871	23·54	23·46	65 1 28	89 31 38	·00553	+ ·00005
1868·5 ...	·99927	23·92	23·84	65 5 35	89 30 0	·00552	+ ·00005
1869·5 ...	·99977	24·00	24·18	65 9 15	89 30 52	·00550	+ ·00006
1870·5 ...	1·00021	24·36	24·48	65 12 29	89 29 17	·00550	+ ·00006
1871·5 ...	1·00060	24·79	24·74	65 15 18	89 26 36	·00550	+ ·00005
1872·5 ...	1·00093	25·05	24·96	65 17 40	89 25 12	·00549	+ ·00005
1873·0 ...	1·00107	...	25·05	65 18 39	.....	·00549	.....

*From March to December 1872 the actual scale reading was about 5·4 divisions, or 1°, less than the corrected value entered in Table 85: consequently the scale coefficient should have been about ·008 of itself greater than appears in column 7.

The only further datum required ($X_o a = 8{\cdot}0581 \times {\cdot}46108 \times \sin 10'{\cdot}80$) is $3{\cdot}7154 \sin 10'{\cdot}80$ $= {\cdot}011672$. The values of $\frac{X}{3{\cdot}7154}$ are those referred to in paragraph 211 and those of $(A - v)$ are taken from column 4 of Table 79.

The mean value of the adopted coefficients for the whole period (1856·0 to 1873·0) is ·00557.

The time may come when it will be worth while to take account of the small errors shown in the last column, repeating the conversions into force for the whole period, but for the present we deem it sufficient to state the errors and leave it to the judgment of the reader to decide whether they should be applied for any special use of the records that he may contemplate making.

Temperature coefficient of Grubb's horizontal force magnetometer.

215. Provisional values of the coefficient were found, in the first place, by means of the natural changes of the temperature of the instrument. Entering the mean temperature of the instrument for every day in the year side by side with the corresponding mean daily scale-reading, the differences of every two successive entries of scale-reading divided by the corresponding differences of temperature would, if the mean readings were unaffected by other causes, give independent values of the temperature coefficient. Taking then the sum of all the differences of temperature (regardless of their signs) in the year, and after changing the signs of all those differences of scale-reading for which the corresponding differences of temperature were negative, adding together also the differences of scale-reading with their proper signs, the quotient of the latter sum divided by the former gives the mean coefficient for the year, and is the equivalent of the mean of all the daily determinations, giving weight to each proportional to the temperature difference which furnished it. The actual calculations were much shortened, but without altering the principle of procedure, except that, when the change of mean temperature between two successive days or the *progressive* change in the same direction of the mean temperature of a series of days did not reach or aggregate 1°, the pairs of differences for such periods were thrown out of account. The treatment of all the observations from 1856 to 1865 in this manner gave 0·143 scale-division, as the diminution of scale-reading produced by an increase of temperature of 1° Fahrenheit. The extreme values for any of the ten years were 0·126 and 0·160; it is therefore evidently a very safe assumption to make that any individual determination which gives a value less than ·000 or greater than ·300 is untrue; in other words, that the effect of difference of horizontal force on the two days which furnish it, over-rides the effect of difference of temperature: in a fresh determination every such individual value was rejected, and the comparisons of mean scale-readings and mean temperatures were made not only between every two successive days, but between every day and the five preceding and five following days: the coefficient was now found to be 0·1506, with limiting values for the individual years of 0·136 and 0·158.

216. As the diurnal ranges of temperature of the instrument are much greater in winter than during the monsoon, the investigation was made separately for half-years commencing with the 1st November and 1st May, and the individual and combined results were as follows, Δs standing for differences of scale-division and Δt for differences of temperature.

Table 86.

Excluding pairs of differences that gave to $\frac{\Delta s}{\Delta t}$ *values outside the limits* ·000 *and* −·300.

Half-year commencing November 1.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$.	$\Sigma(\Delta t)$.	Half-year commencing May 1.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$.	$\Sigma(\Delta t)$.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$. Mean for year.
1856	−·1609	796·2	1857	−·1446	302·0	−·1527
1857	−·1396	676·7	1858	−·1403	356·7	−·1400
1858	−·1580	525·9	1859	−·1590	310·7	−·1585
1859	−·1345	465·4	1860	−·1367	430·3	−·1356
1860	−·1674	594·0	1861	−·1749	417·0	−·1711
1861	−·1543	403·4	1862	−·1412	397·7	−·1477
1862	−·1659	693·7	1863	−·1414	332·9	−·1536
1863	−·1473	620·3	1864	−·1362	365·8	−·1417
1864	−·1684	383·2	1865	−·1405	472·7	−·1544
Mean Winter result.	−·1551		Mean Summer result.	−·1461		−·1506

TABLE 87.

Including the pairs of differences that were rejected in the calculation of the numbers of the preceding table.

Half-year commencing November 1.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$	$\Sigma(\Delta t)$.	Half-year commencing May 1.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$	$\Sigma(\Delta t)$.
1856 ...	−·1621	941·0	1857 ...	−·1589	435·7
1857 ...	−·0938	1077·4	1858 ...	−·1190	589·5
1858 ...	−·1790	949·1	1859 ...	−·1647	603·3
1859 ...	−·2023	758·2	1860 ...	−·0696	732·7
1860 ...	−·1853	932·4	1861 ...	−·1859	657·5
1861 ...	−·1189	633·3	1862 ...	−·1170	641·8
1862 ...	−·2060	974·3	1863 ...	−·1328	591·4
1863 ...	−·1822	877·8	1864 ...	−·0769	581·3
1864 ...	−·2054	601·1	1865 ...	−·0507	719·6
Mean Winter result.	−·1706	...	Mean Summer result.	−·1175	...

217. On the strength of results of the first table, which support each other as effectively as could possibly be expected, it was resolved to adopt the final result ·1506, or rather, as the last figure has no practical significance, ·15 in the correction for temperature of the readings of the horizontal force magnetometer from 1856·0 to 1873·0.

218. Similar investigations were undertaken for the years 1847 to 1850 and 1852 to 1855, rejecting for these periods pairs of differences which gave to $\frac{\Delta s}{\Delta t}$ values outside the limits ·000 and −·045, and the results found for the several years were

Year.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$
1847 ...	−·198
1848 ...	−·213
1849 ...	−·171
1850 ...	−·216
Mean ...	−·200

Year.	$\frac{\Sigma(\Delta s)}{\Sigma(\Delta t)}$
1852 ...	−·198
1853 ...	−·241
1854 ...	−·205
1855 ...	−·199
Mean ...	−·211

The corrections applied to the observations were at the rate of ·20 *per* degree from 1847 to 1850, and ·21 *per* degree from 1851 to 1855.

219. If we convert the value (·1506) found for the period 1856 to 1865 into the same scale as the mean of the other two values, by multiplying by its own scale-coefficient (·0014996) and dividing by theirs (·0009737), it becomes ·232; and it would appear from the gradual increase of the three numbers (·200, ·211 and ·232) that the temperature coefficient is, for some reason, subject to a gradual change with time: the evidence is, however, scarcely such as to justify the assumption of change at a uniform rate, and—as already stated—the coefficients adopted have been ·20, ·21 and ·15 for the three successive periods.

220. In preparation for the heating experiments upon the horizontal force magnetometer, and with a view to rendering the instrument more retentive of the heat which was imparted to it, it was surrounded with inner walls and a ceiling of bamboo matting, and the copper stove was surrounded in the same way by an adjoining enclosure: an inner room, with two compartments, was thus formed within the magnetic observatory, which is itself a building of substantial masonry walls with tiled roof and a calico ceiling. A thermometer was attached outside the magnetometer and was read at the same time as the thermometer belonging to and placed within the box of the instrument, the object being that times of what may be called a state of steady flow of heat should be distinguished from other times by steadiness in the difference of the readings of the two thermometers or by parallelism of their movements within a small range. The observations

taken at such times only were regarded as fit to be made use of for the present purpose. The first operation performed upon the observed scale-readings was to reduce them all to the constant temperature 82°—using the adopted coefficient ·1506, and it is these reduced readings that will be compared with the temperature variations. By means of tabulations of the curves of the horizontal force magnetograph the readings were further corrected for changes of horizontal force that occurred during the course of the experiments, and both the corrected and uncorrected readings are shown in the following table. The table also shows the readings of the two thermometers—inside and outside the magnetometer box—and the division of the observations into groups of steady difference of temperature both at high and low temperatures is indicated by the brackets on the right hand side.

TABLE 88.

January 1879. Date.	Colaba mean time.	Grubb's Horizontal Force Magnetometer. Scale-reading.	Grubb's Horizontal Force Magnetometer. Thermometer.	Thermometer outside.	Scale-reading of Grubb's Horizontal Force Magnetometer. Reduced to temperature 82°.	Scale-reading of Grubb's Horizontal Force Magnetometer. Corrected further for change of Horizontal Force.	January 1879. Date.	Colaba mean time.	Grubb's Horizontal Force Magnetometer. Scale-reading.	Grubb's Horizontal Force Magnetometer. Thermometer.	Thermometer outside.	Scale-reading of Grubb's Horizontal Force Magnetometer. Reduced to temperature 82°.	Scale-reading of Grubb's Horizontal Force Magnetometer. Corrected further for change of Horizontal Force.
	h. m.							h. m.					
10a	5 4	14·51	76·9	71·8	13·75	13·75	14	6 4	14·87	76·3	74·7	14·01	14·01
	5 19	14·54	76·9	71·9	13·78	13·76		6 34	14·84	76·5	74·7	14·01	14·06
	5 34	14·58	76·8	71·7	13·80	13·77		6 49	14·76	76·6	74·8	13·95	14·03
	5 49	14·61	76·8	71·8	13·83	13·79		7 4	14·83	76·8	75·1	14·05	14·12
	6 4	14·64	76·8	71·8	13·86	13·80		7 19	14·75	77·0	75·5	14·00	14·10
11a c	5 4	15·12	74·1	72·5	13·93	13·95		7 34	14·65	77·1	76·0	13·91	14·01
	5 19	15·20	74·1	72·6	14·01	14·01	b.	15 4	11·39	101·0	103·5	14·25	14·09
	5 34	15·12	74·2	72·7	13·95	13·95		15 19	11·41	100·2	102·3	14·15	14·00
	5 49	15·12	74·3	72·6	13·96	13·96		15 34	11·49	99·8	100·5	14·17	14·03
	6 4	15·00	74·3	72·5	13·84	13·84		15 49	11·53	99·0	99·0	14·09	13·97
	6 34	15·23	74·2	72·3	14·06	14·01		16 4	11·59	98·1	97·3	14·01	13·94
	6 49	15·23	74·2	72·0	14·06	13·99		16 23	11·69	97·0	95·4	13·95	13·91
	7 4	15·27	74·1	72·0	14·08	14·00		16 34	11·76	96·7	96·5	13·98	13·97
	7 19	15·30	74·1	72·3	14·11	14·06		16 49	11·82	96·1	96·1	13·94	13·93
	7 34	15·31	74·2	72·5	14·14	14·08		17 4	11·86	95·9	94·8	13·96	13·97
b.	15 32	11·84	97·5	99·9	14·18	14·21	15a	5 4	14·36	78·4	75·4	13·82	13·72
	15 40	11·88	97·2	99·5	14·17	14·22		5 19	14·36	78·4	75·4	13·82	13·74
	15 59	11·92	96·4	96·8	14·09	14·17		5 34	14·50	78·3	75·3	13·94	13·82
	16 5	11·90	96·1	97·0	14·02	14·09		5 49	14·45	78·3	75·0	13·89	13·76
	16 20	12·05	95·8	97·7	14·13	14·18		6 4	14·56	78·2	75·2	13·99	13·87
	16 34	12·09	95·2	97·5	14·08	14·13		6 34	14·55	78·0	75·0	13·95	13·85
	16 49	12·15	95·0	96·0	14·11	14·13		6 49	14·59	78·0	74·9	13·99	13·92
	17 4	12·22	94·5	94·5	14·10	14·11		7 4	14·70	78·0	74·9	14·10	14·04
12a	5 4	14·56	77·2	74·5	13·84	13·90		7 19	14·70	78·0	75·0	14·10	14·05
	5 19	14·50	77·2	74·6	13·78	13·83		7 34	14·70	78·0	75·4	14·10	14·05
	5 34	14·52	77·4	74·8	13·83	13·88	b.	15 39	11·45	102·0	112·7	14·46	14·25
	5 49	14·50	77·4	74·8	13·81	13·86		15 49	11·32	102·9	113·2	14·47	14·27
	6 4	14·59	77·2	74·4	13·87	13·89		16 4	11·47	103·2	111·5	14·36	14·18
	6 39	14·66	77·0	73·8	13·91	13·92		16 20	11·02	104·0	107·0	14·33	14·21
	6 49	14·67	77·0	73·8	13·92	13·93		16 34	10·95	103·4	106·4	14·17	14·09
	7 4	14·60	76·9	73·9	13·84	13·84		16 49	10·96	102·9	102·7	14·11	14·09
	7 19	14·60	76·9	74·2	13·84	13·82		17 4	11·06	101·4	98·0	13·98	13·96
	7 34	14·75	76·9	74·5	13·99	13·97	16a	5 4	14·25	79·2	75·7	13·83	13·84
14a	5 4	14·85	76·4	74·5	14·01	14·02		5 19	14·26	79·0	75·5	13·81	13·79
	5 19	14·90	76·4	74·4	14·06	14·05		5 34	14·46	78·9	75·4	14·00	14·00
	5 34	14·87	76·3	74·5	14·01	14·00		5 49	14·36	78·6	74·7	13·85	13·84
	5 49	14·82	76·3	74·7	13·96	13·96		6 4	14·50	78·3	74·4	13·94	13·90

(a) Doors and transit shutters kept open from 9 d. 22½ h. to 10 d. 7 h.
" " " " 10 22½ to 11 7 50
" " " " 11 22½ to 12 7½
" " " " 13 22½ to 14 7½
" " " " 14 22½ to 15 7½
" " " " 15 22½ to 16 7½

(b) Fire made in stove at 11 d. 12 h. 20 m.
" " 14 11½
" " 15 12 20

(c) Cotton-padded covers of magnetometer box removed at 10d. 22½h., and replaced when the series of experiments was completed.

TABLE 88—*continued.*

January 1879. Date.	Celâba mean time.	Grubb's Horizontal Force Magnetometer.		Thermometer outside.	Scale-reading of Grubb's Horizontal Force Magnetometer.		January 1879. Date.	Celâba mean time.	Grubb's Horizontal Force Magnetometer.		Thermometer outside.	Scale-reading of Grubb's Horizontal Force Magnetometer.	
		Scale-reading.	Thermometer.		Reduced to temperature 82°.	Corrected further for change of Horizontal Force.			Scale-reading.	Thermometer.		Reduced to temperature 82°.	Corrected further for change of Horizontal Force.
	h. m.							h. m.					
16	6 34	14·62	78·0	74·0	14·02	13·93							
	6 49	14·56	77·8	73·6	13·93	13·91	20	20 6	11·15	99·8	100·4	13·83	14·08
	7 4	14·57	77·7	73·5	13·92	13·91		20 19	11·24	99·6	98·9	13·89	14·04
	7 19	14·67	77·8	74·0	14·04	14·07		20 34	11·38	99·5	98·1	14·02	14·10
	7 34	14·75	77·7	74·1	14·10	14·12		20 49	11·38	99·3	100·2	13·99	14·14
b.	15 4	11·14	103·0	114·5	14·30	14·29		21 6	11·10	99·1	98·9	13·67	14·09
	15 19	10·94	103·9	113·3	14·24	14·21		21 19	10·92	99·0	99·8	13·48	14·10
	15 34	10·84	104·5	110·3	14·23	14·19		21 34	10·82	99·1	99·0	13·39	14·12
	15 49	10·67	105·0	108·5	14·13	14·15		21 49	10·67	99·0	99·3	13·23	14·08
	16 4	10·70	104·5	107·0	14·09	14·13		22 6	10·67	99·0	99·0	13·23	14·11
	16 20	10·74	104·0	106·6	14·05	14·01		22 19	10·74	99·0	100·2	13·30	14·12
	16 36	10·81	103·9	107·4	14·11	14·09		22 34	10·78	99·0	97·9	13·34	14·11
	16 49	10·80	103·6	107·6	14·05	14·03		22 49	10·85	98·7	98·1	13·37	14·15
	17 4	10·76	103·2	107·3	13·95	13·98		23 6	10·85	98·5	96·0	13·34	14·16
17*a*	5 4	14·38	78·1	74·7	13·79	13·84		23 19	10·97	98·2	96·1	13·41	14·13
	5 19	14·34	78·1	74·7	13·75	13·79		23 34	11·09	97·8	97·2	13·47	14·12
	5 34	14·51	78·0	74·7	13·91	13·94		23 49	11·20	97·8	98·4	13·58	14·16
	5 49	14·42	78·0	74·8	13·82	13·86	21	0 6	11·21	98·0	96·4	13·62	14·16
	6 4	14·40	78·0	74·8	13·80	13·84		0 19	11·30	97·9	95·8	13·70	14·16
	6 36	14·46	77·9	74·4	13·85	13·85		0 34	11·26	97·4	95·4	13·58	14·09
	6 49	14·43	77·9	74·0	13·82	13·82		0 49	11·37	97·1	94·4	13·64	14·08
	7 4	14·45	77·4	74·0	13·76	13·76		1 6	11·53	96·8	92·6	13·76	14·11
	7 19	14·45	77·3	74·5	13·74	13·72		1 19	11·76	96·0	91·5	13·87	14·05
	7 34	14·53	77·4	75·0	13·84	13·82		1 34	11·80	95·3	92·4	13·81	14·05
18	6 14	14·27	79·0	...	13·82	13·98		1 49	11·71	95·3	93·1	13·72	14·13
	10 14	14·57	79·0	...	14·12	14·04		2 6	11·65	95·2	93·5	13·64	14·14
	14 14	14·21	82·9	...	14·35	14·23		2 19	11·60	95·1	91·6	13·57	14·09
	16 14	14·00	83·8	...	14·27	14·20		2 34	11·58	94·9	92·0	13·53	14·05
	22 14	13·99	80·9	...	13·83	14·02		2 49	11·65	94·8	92·6	13·58	14·09
19	6 14	14·50	78·1	...	13·91	13·95		3 6	11·67	94·6	92·0	13·57	14·08
	10 14	14·65	78·3	...	14·09	14·16		3 19	11·81	94·5	94·6	13·70	14·18
	14 14	14·10	81·0	...	13·95	14·20		3 34	11·74	94·9	93·8	13·69	14·19
	16 14	13·99	82·0	...	13·99	14·24		3 49	11·72	95·0	93·8	13·68	14·15
	22 14	14·27	80·0	...	13·97	14·05		4 6	11·77	95·0	97·0	13·73	14·18
20	6 14	14·85	77·2	...	14·13	14·09		4 19	11·77	95·3	97·5	13·78	14·20
	10 14	14·76	78·6	...	14·25	14·15		4 34	11·69	96·0	96·5	13·80	14·22
b.	14 34	11·35	101·6	107·6	14·30	14·21		4 49	11·66	96·0	96·0	13·77	14·17
	14 49	11·42	101·0	109·0	14·28	14·18		5 6	11·64	96·0	96·0	13·75	14·13
	15 4	11·32	101·8	108·0	14·30	14·24		5 19	11·64	96·0	94·5	13·75	14·12
	15 19	11·14	102·1	106·3	14·16	14·17		5 34	11·71	95·9	94·3	13·81	14·17
	15 34	11·00	102·1	104·5	14·02	14·14		5 49	11·76	95·9	95·8	13·86	14·21
	15 49	10·96	102·0	106·0	13·97	14·14		6 6	11·74	95·9	92·0	13·84	14·19
	16 4	10·91	102·1	105·5	13·93	14·11		6 19	11·77	95·2	91·8	13·76	14·13
	16 19	10·97	102·0	103·8	13·98	14·12		6 34	11·87	95·0	96·8	13·83	14·18
	16 34	11·04	101·9	102·3	14·04	14·12		6 49	11·81	95·3	96·0	13·82	14·16
	16 49	11·11	101·4	101·0	14·03	14·04		7 6	11·78	96·0	96·1	13·89	14·21
	17 4	11·15	100·9	100·6	14·00	14·05		7 19	11·75	96·0	96·0	13·86	14·19
	17 19	11·22	100·4	100·3	13·99	14·05		7 34	11·69	96·1	96·5	13·81	14·17
	17 34	11·28	100·0	98·5	13·99	14·01		7 49	11·67	96·2	95·5	13·81	14·15
	17 49	11·38	99·6	97·5	14·03	14·06		8 6	11·64	96·3	95·8	13·80	14·17
	18 4	11·38	99·3	99·7	13·99	14·07		8 19	11·65	96·2	97·0	13·79	14·15
	18 19	11·44	99·0	99·4	14·00	14·04		8 34	11·61	96·8	96·2	13·84	14·19
	18 34	11·45	99·2	100·8	14·04	14·07		8 49	11·63	97·0	97·7	13·89	14·21
	18 49	11·39	99·3	99·8	14·00	14·03		9 6	11·61	97·1	96·5	13·88	14·18
	19 4	11·38	99·3	99·6	13·99	14·09		9 19	11·64	97·0	96·9	13·90	14·18
	19 19	11·37	99·2	100·6	13·96	14·08		9 34	11·67	97·0	97·5	13·93	14·19
	19 34	11·34	99·3	99·8	13·95	14·08		9 49	11·66	97·1	97·0	13·93	14·15
	19 49	11·22	99·4	100·9	13·84	14·13		10 6	11·70	97·1	98·0	13·97	14·15

(*a*) Doors and transit shutters kept open from 16d. 22½h. to 17d. 7½h.
(*b*) Fire made in stove at 16d. 11h. 25m.
" " " " 20d. 11h. 45m.

TABLE 88—*continued.*

January 1879. Date.	Colâba mean time.	GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Scale-reading.	GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Thermometer.	Thermometer outside.	SCALE-READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Reduced to temperature 82°.	SCALE-READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Corrected further for change of Horizontal Force.
	h. m.					
21	10 19	11·74	97·5	101·8	14·08	14·26
	10 34	11·61	98·6	104·6	14·11	14·33
	10 49	11·44	100·3	105·6	14·20	14·38
	11 6	11·20	101·4	104·8	14·12	14·37
	11 19	11·07	101·8	104·9	14·05	14·30
	11 34	11·02	102·4	110·2	14·09	14·34
	11 49	10·88	104·3	116·5	14·24	14·46
	12 6	10·50	106·3	113·6	14·16	14·38
	12 19	10·27	107·3	113·9	14·09	14·31
	12 34	10·06	107·9	113·3	13·97	14·20
	12 49	9·89	108·5	111·1	13·89	14·16
	13 6	9·83	108·5	111·5	13·83	14·13
	13 19	9·80	108·6	114·5	13·81	14·12
	13 34	9·73	109·4	115·3	13·86	14·14
	13 49	9·59	110·0	114·4	13·81	14·10
	14 6	9·48	110·5	114·6	13·78	14·11
	14 19	9·39	111·0	115·2	13·76	14·10
	14 34	9·30	111·0	112·6	13·67	14·02
22	6 14	13·75	82·3	...	13·80	14·11
	10 14	14·17	82·9	...	14·31	14·21
	14 14	13·65	85·9	...	14·24	14·33
	16 14	13·30	87·0	...	14·05	14·30
	22 14	13·85	82·4	...	13·91	14·12
23	6 14	14·39	80·0	...	14·09	14·26
	10 14	14·80	79·8	...	14·47	14·25
	14 14	14·11	83·9	...	14·40	14·44
	16 14	13·66	85·9	...	14·25	14·39
	22 14	14·10	81·8	...	14·07	14·35
27*a*	18 6	14·23	82·0	78·7	14·23	14·30
	18 34	14·32	81·1	78·3	14·18	14·30
	19 6	14·30	80·9	78·3	14·14	14·29
	19 34	14·27	80·8	78·2	14·09	14·28
	20 6	14·31	80·5	78·2	14·08	14·35
	20 34	14·20	80·2	78·2	13·93	14·23
	21 6	14·21	80·1	78·6	13·92	14·30
	21 34	14·19	80·0	78·5	13·89	14·29
	22 6	14·24	79·5	76·9	13·86	14·28
	22 34	14·28	79·0	76·3	13·83	14·28
	23 6	14·20	79·0	76·3	13·75	14·28
	23 34	14·23	78·9	76·3	13·77	14·38
28	0 6	14·30	78·9	76·3	13·84	14·43
	0 34	14·34	78·8	76·5	13·86	14·39
	1 6	14·35	78·6	76·0	13·84	14·46
	1 34	14·43	78·3	75·5	13·87	14·37
	2 6	14·45	78·0	75·2	13·85	14·33
	2 34	14·40	78·0	75·1	13·80	14·29
	3 6	14·38	77·9	74·8	13·77	14·27
	3 34	14·47	77·6	74·3	13·81	14·32
	4 6	14·55	77·4	74·1	13·86	14·38
	4 34	14·57	77·2	74·1	13·85	14·38
	5 6	14·65	77·0	73·7	13·90	14·38
	5 34	14·75	76·8	73·4	13·97	14·40
b	18 6	11·39	100·9	105·9	14·24	14·57
	18 19	11·31	101·0	107·4	14·17	14·52
	18 34	11·21	101·2	105·3	14·10	14·43
	18 49	11·22	101·2	106·0	14·11	14·43
	19 6	11·20	101·0	105·6	14·06	14·39
	19 19	11·18	101·0	105·2	14·04	14·39
	19 34	11·14	101·3	104·3	14·05	14·41
	19 49	11·12	101·0	103·8	13·98	14·35
	20 6	11·13	101·0	103·6	13·99	14·36
	20 19	11·16	101·0	104·0	14·02	14·39

January 1879. Date.	Colâba mean time.	GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Scale-reading.	GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Thermometer.	Thermometer outside.	SCALE READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Reduced to temperature 82°.	SCALE READINGS OF GRUBB'S HORIZONTAL FORCE MAGNETOMETER. Corrected further for change of Horizontal Force.
	h. m.					
28	20 34	11·14	101·0	103·6	14·00	14·38
	20 49	11·13	101·0	103·1	13·99	14·37
	21 6	11·19	100·6	102·0	13·99	14·36
	21 19	11·28	100·1	101·5	14·00	14·37
	21 34	11·36	99·6	100·6	14·01	14·36
	21 49	11·38	99·4	100·7	14·00	14·32
	22 6	11·38	99·4	101·5	14·00	14·32
	22 19	11·36	99·6	100·9	14·01	14·32
	22 34	11·35	99·8	100·4	14·03	14·35
	22 49	11·36	99·5	100·0	14·00	14·35
	23 4	11·42	99·2	99·5	14·01	14·32
	23 19	11·41	99·1	99·6	13·98	14·29
	23 34	11·40	99·0	99·0	13·96	14·28
	23 49	11·43	98·8	98·2	13·96	14·30
29	0 6	11·50	98·0	98·3	13·91	14·27
	0 19	11·52	98·0	97·9	13·93	14·28
	0 34	11·55	98·0	97·9	13·96	14·31
	0 49	11·60	98·0	97·6	14·01	14·31
	1 6	11·62	97·9	97·6	14·02	14·34
	1 19	11·61	97·9	97·5	14·01	14·34
	1 34	11·66	97·6	97·6	14·01	14·34
	1 49	11·65	97·5	97·5	13·99	14·32
	2 6	11·71	97·4	97·2	14·03	14·33
	2 19	11·79	97·0	96·4	14·05	14·37
	2 34	11·82	96·7	96·9	14·04	14·34
	2 49	11·80	96·9	97·4	14·05	14·36
	3 6	11·90	97·1	97·4	14·17	14·36
	3 19	11·90	97·3	97·3	14·21	14·34
	3 34	11·89	97·3	97·1	14·20	14·33
	3 49	11·82	97·5	97·6	14·16	14·37
	4 6	11·70	97·9	98·7	14·10	14·40
	4 19	11·61	98·5	99·1	14·10	14·39
	4 34	11·56	98·9	98·8	14·11	14·39
	4 49	11·56	98·7	98·2	14·08	14·36
	5 6	11·63	98·2	97·6	14·07	14·35
	5 19	11·70	97·7	97·8	14·07	14·35
	5 34	11·79	97·3	97·6	14·10	14·35
	5 49	11·84	97·1	97·6	14·11	14·35
a	18 6	13·32	86·0	80·7	13·92	14·30
	18 34	13·45	85·2	80·6	13·93	14·29
	19 6	13·43	84·8	80·2	13·83	14·21
	19 34	13·52	84·2	80·0	13·85	14·23
	20 6	13·63	84·0	80·0	13·93	14·31
	20 34	13·80	84·0	80·0	14·10	14·48
	21 6	13·95	84·0	80·0	14·25	14·61
	21 34	14·02	83·6	79·9	14·26	14·64
	22 6	14·01	83·2	79·6	14·19	14·54
	22 34	14·03	83·0	79·3	14·18	14·51
	23 4	14·12	82·8	79·3	14·24	14·57
	23 34	14·10	82·4	79·3	14·16	14·51
30	0 6	14·10	82·2	78·5	14·13	14·49
	0 34	14·13	82·0	78·4	14·13	14·48
	1 6	14·22	81·9	77·5	14·21	14·58
	1 34	14·18	81·3	77·5	14·07	14·48
	2 6	14·18	81·1	77·6	14·04	14·40
	2 34	14·24	81·0	77·4	14·09	14·43
	3 6	14·45	80·5	77·3	14·22	14·50
	3 34	14·52	80·3	76·8	14·26	14·45
	4 6	14·61	80·2	76·5	14·34	14·55
	4 34	14·54	80·1	76·7	14·25	14·33
	5 6	14·68	80·0	76·5	14·38	14·46
	5 34	14·76	80·0	76·3	14·46	14·54

a Doors and transit shutters kept open from 27d. 17h. to 28d. 7h.
Do. do. do. 29d. 17h. to 30d. 7h.
b Fire made in stove at 28d. 15h.

221. Mean scale-readings and mean temperatures for the several groups of observations are shown in Table 89, as are also the corresponding pairs of differences for each rise or fall of the temperature of succeeding groups. Although made no use of the means for periods of unsteady difference of temperature (and one superfluous mean) are also entered in the table, but they are distinguished by being enclosed within square brackets.

TABLE 89.

January 1879. From			To			Mean temperature.		Differences.	Mean scale-reading. Reduced to temperature 82°.		Mean.	Corrected further for change of Horizontal Force.		Mean.	Differences of scale-reading. Reduced.	Corrected.	Additional coefficient c in excess above ·1506. Deduced from columns 4 and 7.	Deduced from columns 4 and 8.
1			2			3		4	5			6			7	8	9	10
d.	h.	m.	d.	h.	m.	°												
[10	5	4	10	6	4	76·8			13·80			13·77]						
11	5	4	11	7	34	74·2		21·8	14·01			13·98			+·10	−·17	−·005	−·008
„	15	32	„	17	4	96·0		18·9	14·11			14·15			−·25	−·27	−·013	−·014
12	5	4	12	7	34	77·1			13·86			13·88						
14	5	4	14	7	34	76·6		21·6	14·00			14·04			−·06	+·06	−·003	+·003
„	15	4	„	17	4	98·2		20·0	14·06			13·98			−·09	−·10	−·005	−·005
15	5	4	15	7	34	78·2		24·6	13·97			13·88			−·30	−·27	−·012	−·011
„	15	39	„	17	4	102·8		24·5	14·27			14·15			−·33	−·22	−·013	−·009
16	5	4	16	7	34	78·3		25·7	13·94			13·93			−·19	−·29	−·007	−·011
„	15	4	„	17	4	104·0		26·2	14·13			14·12			−·32	−·30	−·012	−·011
17	5	4	17	7	34	77·8			13·81			13·82						
															Means =		−·009	−·008
							Mean.				Mean.			Mean.				
18	6	14	20	10	14	80·1			14·06			14·11						
[20	14	34	„	16	19	101·8			14·12			14·16]						
„	16	34	21	0	4	99·3			13·74			14·09						
[21	0	19	„	3	6	95·9	97·65	16·0	13·66		13·78	14·09]		14·13	+·33	+·065	+·021*	+·004
„	3	19	„	10	6	96·0	81·65		13·82		14·11	14·17		14·195				
[„	10	19	„	14	34	105·8			13·97			14·23]						
22	6	14	23	22	14	83·2			14·16			14·28						
27	18	6	28	5	34	79·0			13·91			14·33						
[28	18	6	28	20	49	101·0			14·06			14·42]						
„	21	6	29	5	49	98·3	80·3	18·0	14·04		14·06	14·34		14·415	+·02	+·075	+·001†	+·004
[29	18	6	30	5	34	82·4			14·14			14·45]						
„	21	6	30	5	34	81·6			14·21			14·50						
															Means =		−·011	+·004

* This is largely affected by a magnetic disturbance that was in progress between 20d. 19h. and 21d. 14h.
† Affected by a disturbance between 27d. 18h. and 28d. 5h. 34m.

222. Adding the mean of the two results (−·008 and +·004) to ·1506 we find as the final value of the coefficient given by these experiments ·1486. At this time the scale-coefficient was ·00574, whilst its mean value from 1856·0 to 1873·0 was ·00557 : consequently the temperature coefficient for the latter period would be $\cdot1486 \frac{\cdot00574}{\cdot00557}$ or ·1531, which differs by only ·0025 from the value that has been adopted. For 1856 to 1865, the years which yielded the adopted value of the temperature coefficient, the mean scale-coefficient was ·00560, so that the experimental value reduced to the same scale is ·1523, or still nearer to the adopted value. This agreement would seem to imply that temperature coefficients determined, in the manner described in paragraph 215, from the observations themselves may be depended upon, or—what comes to the same thing—that the horizontal force is not a function of the natural temperature of the station of observation as shown in its variations from day to day ; but it will be seen further on that it is still an open question whether a considerable part of the variation of horizontal force exhibited at a height of 6 feet above the ground may not march in close correspondence with natural temperature as shown in its variations from hour to hour.

223. *Disturbance variations—diurnal, annual and secular.*—The following tables exhibit the general results as to diurnal, annual and secular variations of disturbance when the separating value made use of is ·00334 *mm-mg-s* unit of force.

TABLE 90.—*Showing, for the period* 1847 *to* 1872, *the aggregates of disturbances increasing the horizontal force* * *exceeding* ·00334 *in amount, for each hour of the day in each month of the year.*

Bombay Civil Hours.		Aggregates of Northerly Disturbances.											
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
h.	m.												
0	14	·04320	·02385	·02193	·05608	·01130	·03754	·00000	·01563	·06800	·01701	·01149	·01559
1	14	·01805	·03286	·01102	·05026	·02461	·03700	·00000	·01280	·02355	·04081	·02658	·00731
2	14	·03486	·00729	·01414	·03190	·00955	·02452	·00410	·01832	·01875	·01116	·02305	·00710
3	14	·01509	·02492	·01125	·02741	·00387	·01679	·00756	·02146	·01185	·01931	·01946	·02208
4	14	·02573	·00770	·00974	·02467	·01636	·02758	·01150	·03618	·01140	·02236	·02235	·01295
5	14	·04899	·02073	·01304	·02692	·02122	·01633	·02844	·02903	·02064	·02132	·03338	·01066
6	14	·04600	·02837	·02190	·05027	·00369	·03130	·04892	·03343	·03596	·03438	·03511	·01479
7	14	·04532	·01584	·04306	·05807	·02495	·04353	·05620	·05745	·03443	·05192	·05064	·02098
8	14	·05480	·05412	·08367	·07239	·05048	·05500	·06473	·07028	·05289	·10311	·07743	·04333
9	14	·09346	·12038	·08340	·09786	·09916	·10259	·08976	·10300	·12948	·13786	·09587	·04369
10	14	·09328	·11056	·16937	·13777	·09313	·10929	·11383	·15421	·15745	·15918	·09864	·04822
11	14	·13472	·11255	·20811	·14411	·08235	·11582	·11398	·14092	·18560	·14996	·10347	·04287
12	14	·13801	·12286	·17502	·12335	·07194	·12253	·10438	·13256	·16872	·13448	·11826	·04584
13	14	·11383	·13014	·08685	·11355	·07046	·10865	·09389	·15246	·10021	·12589	·11051	·02544
14	14	·10297	·12236	·07074	·06289	·07533	·07683	·09610	·14176	·08079	·18944	·05938	·04566
15	14	·06841	·09166	·06670	·04461	·04880	·06233	·04838	·05523	·03495	·12659	·05831	·03345
16	14	·05623	·08988	·06755	·02516	·03201	·05116	·03507	·05447	·01758	·11523	·04106	·04679
17	14	·03288	·05592	·05907	·03295	·04026	·04407	·04345	·02528	·02725	·07359	·03578	·02626
18	14	·03393	·04119	·02966	·03723	·03254	·02950	·04110	·04047	·04938	·08431	·06826	·02159
19	14	·04961	·03352	·02195	·04614	·01226	·03514	·03764	·03018	·03597	·06339	·06125	·02276
20	14	·04779	·02370	·03759	·03281	·01752	·03889	·03350	·02254	·02701	·04652	·07217	·02856
21	14	·03997	·04518	·04382	·02914	·00799	·02442	·01849	·02058	·04626	·04361	·07517	·01798
22	14	·05939	·02197	·02051	·02833	·00405	·03223	·01484	·02837	·04885	·03513	·06531	·01885
23	14	·05177	·01163	·00737	·03720	·01118	·03713	·00769	·03104	·05480	·04034	·06425	·00768

* Hereafter, for the sake of brevity, disturbances increasing and decreasing the horizontal force will be called also northerly and southerly disturbances respectively.

Curves representing these aggregates are numbered 390 to 401 on Plate XXI.

TABLE 91.—*Showing, for the period* 1847 *to* 1872, *the aggregates of disturbances decreasing the horizontal force exceeding* ·00334 *in amount, for each hour of the day in each month of the year.*

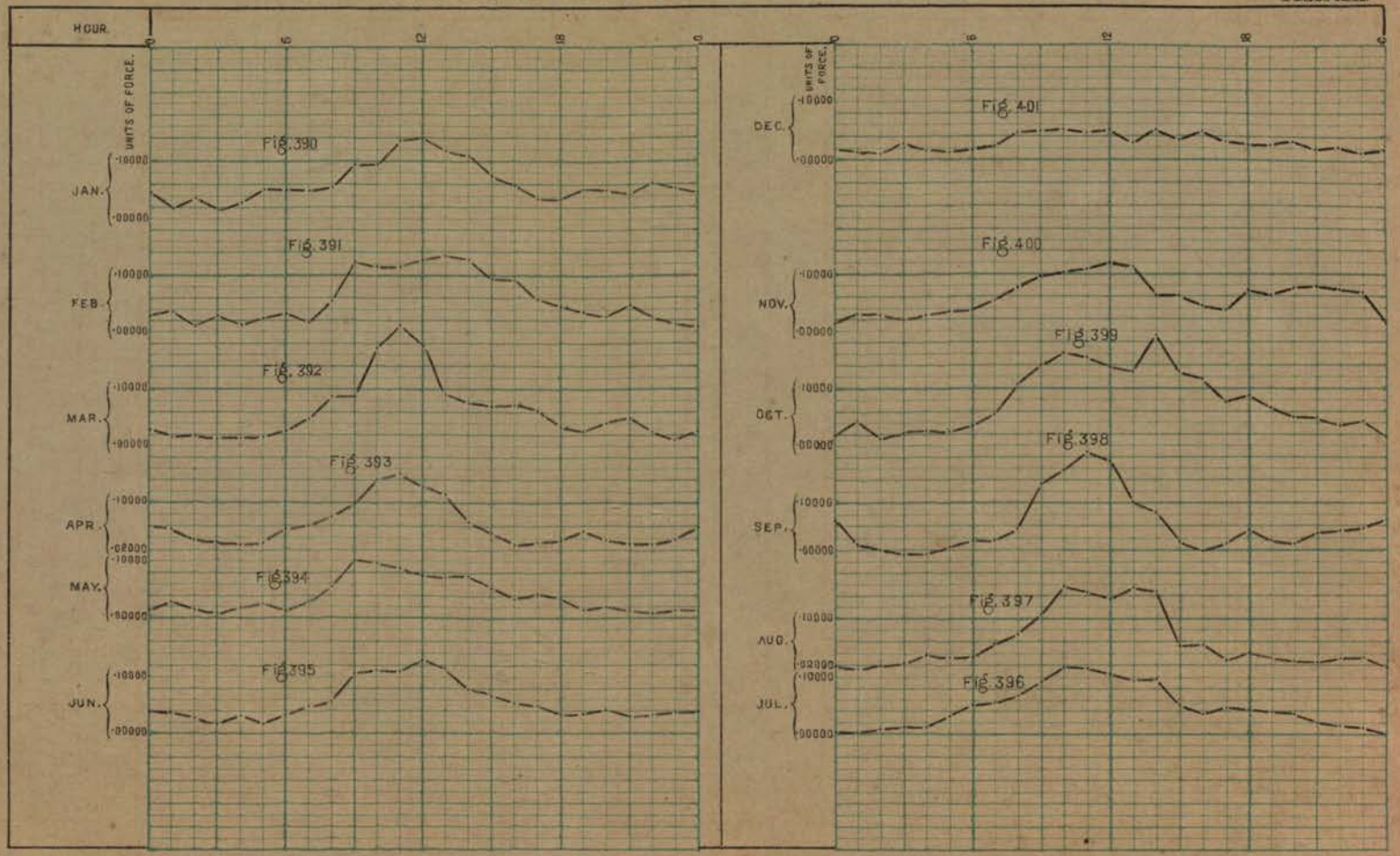
Bombay Civil Hours.		Aggregates of Southerly Disturbances.											
		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
h.	m.												
0	14	·28066	·42819	·28343	·33557	·18748	·10304	·18901	·25807	·38116	·56871	·27501	·35822
1	14	·26708	·41780	·24099	·32397	·13866	·10940	·14539	·24094	·36751	·46518	·25528	·31896
2	14	·23022	·39636	·15292	·24676	·15877	·09874	·14712	·21699	·29649	·39574	·21892	·30917
3	14	·19609	·33188	·16928	·22414	·13849	·09994	·12678	·19277	·26590	·29425	·21605	·24228
4	14	·17532	·30505	·14872	·19426	·11475	·10030	·12846	·19602	·23732	·24669	·18337	·24295
5	14	·18469	·30498	·13774	·17044	·10650	·05968	·11658	·20074	·25736	·30914	·20058	·22986
6	14	·14919	·28258	·13221	·20538	·12132	·07701	·11262	·15202	·23781	·34135	·22119	·24577
7	14	·12927	·27031	·13811	·24618	·17175	·09849	·12415	·15958	·29405	·35258	·22577	·23325
8	14	·15168	·26519	·16679	·29665	·19458	·16324	·15219	·22447	·31800	·40544	·20939	·21875
9	14	·16212	·34895	·26492	·36921	·25676	·21668	·21100	·27813	·39660	·50300	·23493	·23902
10	14	·16701	·39551	·26611	·39080	·32290	·28932	·24629	·30247	·46746	·56080	·23366	·27348
11	14	·16788	·47174	·26878	·41099	·32560	·27434	·29070	·33164	·50587	·62953	·28149	·30980
12	14	·21269	·49647	·31988	·43404	·36062	·28268	·30986	·34183	·51238	·69620	·27761	·25406
13	14	·23112	·48592	·40505	·40618	·34185	·26080	·28190	·36490	·58927	·64189	·32218	·26731
14	14	·20624	·41740	·40076	·40660	·30924	·25736	·25277	·34756	·59044	·58677	·36955	·29493
15	14	·24735	·39755	·36859	·44432	·30176	·23791	·25055	·39209	·65166	·63456	·35112	·32289
16	14	·28764	·39173	·42220	·49755	·27688	·22418	·25303	·40003	·69785	·66040	·38899	·39553
17	14	·31694	·45621	·40383	·42365	·30371	·20809	·27585	·44874	·63612	·66039	·42039	·41510
18	14	·27718	·48402	·42763	·45175	·31227	·17014	·28048	·40061	·64959	·73025	·38630	·41787
19	14	·28913	·52183	·44041	·49106	·26602	·13299	·26575	·37473	·63761	·70461	·38140	·46023
20	14	·31654	·49930	·38739	·49184	·22855	·14241	·25839	·35258	·57137	·69664	·39606	·46168
21	14	·27732	·49909	·32009	·44044	·20213	·15826	·24162	·33107	·52616	·67453	·33218	·44512
22	14	·28075	·45360	·34339	·42864	·24414	·12740	·20982	·25869	·44731	·69463	·29452	·40610
23	14	·24372	·40967	·32442	·36380	·22615	·10671	·19365	·21839	·37841	·61738	·27730	·38796

Curves representing these aggregates are numbered 402 to 413 on Plate XXII.

COLABA OBSERVATORY,—DISTURBANCES OF HORIZONTAL FORCE.

AGGREGATES OF DISTURBANCES INCREASING THE HORIZONTAL FORCE IN EACH MONTH—DIURNAL VARIATION.

Plate XXI.



COLABA OBSERVATORY,— DISTURBANCES OF HORIZONTAL FORCE

AGGREGATES OF DISTURBANCES DECREASING THE HORIZONTAL FORCE IN EACH MONTH:— DIURNAL VARIATION.

Plate XXII.

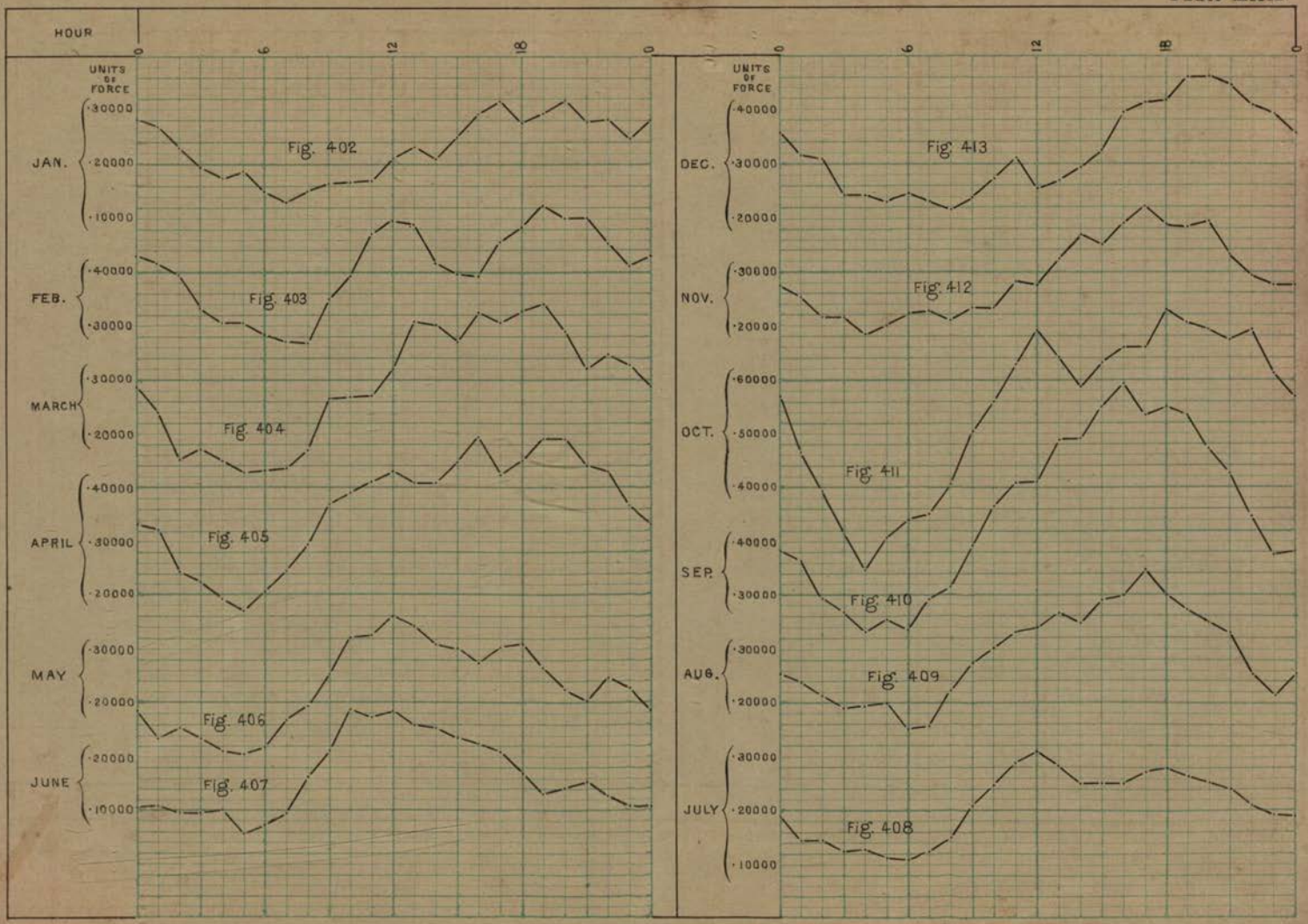


TABLE 92.—*Showing, for the period* 1847 *to* 1872, *the aggregates of disturbances increasing the horizontal force exceeding* ·00334 *in amount, for each hour of the day in each of the years* 1847 *to* 1872.

Bombay Civil Hours.	AGGREGATES OF NORTHERLY DISTURBANCES.												
	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.													
0 14	·00000	·01519	·00400	·00000	·00454	·01742	·02332	·00000	·00000	·01961	·00000	·00811	·01206
1 14	·00374	·00709	·01019	·00000	·00000	·03586	·01296	·00369	·00000	·01265	·00352	·02072	·00729
2 14	·00000	·00778	·00378	·00000	·00000	·00976	·00734	·00000	·00000	·01756	·00000	·01464	·00684
3 14	·00738	·00342	·01343	·00353	·00000	·00882	·01336	·00350	·00000	·00456	·00000	·01379	·01997
4 14	·00000	·00421	·01260	·00544	·00000	·00504	·01237	·00518	·00000	·00872	·00000	·00856	·01571
5 14	·00518	·01184	·00788	·00349	·00364	·00414	·00891	·00000	·00000	·00821	·00000	·00704	·02177
6 14	·00360	·01368	·00900	·00000	·00648	·01253	·01690	·01248	·00000	·00787	·00000	·01210	·01167
7 14	·00896	·03366	·01609	·01148	·00760	·01127	·01121	·01168	·00000	·00000	·00499	·03237	·03495
8 14	·01361	·05062	·01109	·01152	·01516	·02038	·01088	·01215	·00369	·00359	·01729	·05405	·06547
9 14	·01994	·04608	·01994	·01318	·05105	·03766	·02654	·03044	·01544	·01197	·03192	·06756	·05677
10 14	·02498	·05123	·03240	·02164	·04493	·04748	·03701	·01602	·00821	·01556	·04723	·05422	·08746
11 14	·03607	·03550	·02516	·02257	·03996	·06642	·03369	·01584	·01383	·01624	·06180	·05123	·10221
12 14	·02473	·03539	·01922	·01930	·04421	·08320	·03329	·02909	·01836	·00348	·02432	·03530	·10956
13 14	·01670	·03917	·02542	·00806	·02225	·05180	·02179	·02128	·01037	·00450	·00397	·03187	·07882
14 14	·00900	·04154	·02099	·01120	·01271	·04687	·03796	·01657	·01026	·00764	·00352	·02888	·05829
15 14	·02034	·01501	·01516	·01454	·01066	·05141	·03358	·01215	·00361	·00365	·00000	·01599	·01924
16 14	·02016	·00382	·01933	·00814	·00821	·06833	·02836	·00000	·00376	·00958	·00346	·01458	·02452
17 14	·01145	·00349	·01116	·00000	·00000	·03110	·01464	·00000	·00000	·01334	·00805	·01453	·01285
18 14	·00000	·00464	·00763	·00396	·01202	·01969	·01274	·00000	·00712	·01807	·01196	·02838	·03215
19 14	·00680	·00389	·00403	·00000	·00000	·01519	·01197	·00339	·00442	·01630	·00550	·00687	·01947
20 14	·00000	·00389	·00803	·00000	·00482	·01098	·01234	·00361	·00431	·01824	·00510	·01571	·02266
21 14	·00929	·01627	·00385	·00835	·00374	·01508	·00358	·00000	·00000	·01311	·00414	·02708	·00707
22 14	·01048	·01087	·00400	·00403	·00356	·01084	·00401	·00409	·00000	·01374	·00000	·01965	·01548
23 14	·00000	·01166	·01354	·00000	·00907	·01008	·02175	·00000	·00000	·01870	·00000	·01565	·01234

TABLE 92—*continued.*

Bombay Civil Hours.	AGGREGATES OF NORTHERLY DISTURBANCES.												
	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h. m.													
0 14	·01217	·01789	·00930	·01835	·00344	·01950	·00702	·00503	·00342	·01287	·06517	·02799	·01526
1 14	·02093	·01738	·02334	·00812	·00339	·02011	·00343	·01261	·00381	·01474	·00000	·01650	·02284
2 14	·02171	·00369	·01487	·01384	·00366	·01557	·00000	·01300	·00425	·01397	·00000	·01655	·01598
3 14	·01571	·00408	·00000	·00823	·00422	·01656	·00337	·01217	·00817	·01551	·00341	·00973	·00873
4 14	·03590	·00755	·00769	·01601	·00000	·01789	·00000	·00813	·00000	·02876	·00770	·01094	·01016
5 14	·03731	·00743	·01810	·01207	·00344	·02449	·01526	·01222	·00364	·02084	·01463	·01919	·02004
6 14	·04881	·02940	·02061	·01257	·01165	·02848	·01808	·01051	·00000	·02145	·02370	·02975	·02284
7 14	·04914	·02560	·03370	·02908	·00783	·02033	·02267	·01123	·00370	·02436	·03212	·02898	·02943
8 14	·04965	·04338	·04601	·03191	·01143	·04144	·04651	·02278	·02352	·02750	·03976	·04856	·06034
9 14	·08561	·07368	·06779	·06978	·04151	·04410	·02483	·01709	·04747	·04103	·09273	·08349	·07900
10 14	·11119	·05909	·07029	·09519	·07215	·04033	·06254	·02372	·06044	·05692	·12314	·12661	·05501
11 14	·10278	·07105	·06890	·10030	·05900	·06903	·04236	·02643	·05250	·06545	·14074	·13590	·07955
12 14	·07327	·07133	·07581	·09724	·08047	·09922	·04203	·02500	·04350	·09069	·11907	·10620	·05474
13 14	·04628	·06138	·06795	·08390	·03724	·09285	·07969	·03655	·05283	·07656	·09636	·08030	·08411
14 14	·04712	·04629	·05553	·06889	·04856	·08692	·06238	·04081	·05426	·06611	·04944	·07997	·11265
15 14	·04342	·02890	·04528	·04198	·03935	·05662	·03180	·02018	·02357	·04713	·05857	·05104	·03629
16 14	·01677	·03628	·02412	·03642	·02592	·08376	·02135	·01985	·01419	·04647	·02398	·04499	·02591
17 14	·03416	·02896	·01214	·01607	·02309	·05712	·03030	·00796	·01308	·01892	·03388	·04779	·05276
18 14	·01060	·02627	·00746	·01535	·01543	·05396	·01239	·00780	·02495	·01441	·06457	·06528	·03239
19 14	·01161	·01481	·00774	·01412	·01138	·08088	·02577	·00000	·02285	·01127	·04026	·06275	·04859
20 14	·02255	·01968	·00473	·02330	·00372	·04764	·01698	·00371	·00707	·02981	·04015	·06490	·03475
21 14	·02070	·01263	·00719	·03108	·01160	·02471	·00730	·00000	·00348	·04092	·05307	·05192	·03651
22 14	·01745	·01336	·01287	·02663	·00499	·02598	·00785	·00763	·00000	·03421	·03652	·05456	·03508
23 14	·01072	·00911	·00852	·02969	·00683	·02776	·01609	·01261	·00000	·01639	·02970	·04598	·03596

Curves representing these aggregates are numbered 414 to 439 on Plate XXIII.

TABLE 93.—*Showing, for the period* 1847 *to* 1872, *the aggregates of disturbances decreasing the horizontal force exceeding* ·00334 *in amount, for each hour of the day in each of the years* 1847 *to* 1872.

Bombay Civil Hours.	Aggregates of Southerly Disturbances.												
	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.													
0 14	·24754	·23659	·05670	·02693	·16236	·08968	·08880	·09610	·02431	·00912	·09095	·15246	·34114
1 14	·23533	·23353	·05821	·02146	·13619	·06520	·06884	·07643	·02172	·00912	·09769	·12960	·30614
2 14	·20477	·19886	·03719	·02801	·10800	·07333	·05358	·05256	·02278	·00769	·08323	·09768	·25284
3 14	·19015	·19310	·04612	·00781	·10001	·07506	·04413	·03752	·00748	·00000	·07394	·09920	·23197
4 14	·17762	·14047	·03366	·01667	·09893	·07114	·03015	·01343	·00777	·00000	·07524	·09008	·21559
5 14	·15412	·15980	·03528	·00760	·10861	·08978	·04679	·02478	·01226	·00000	·06934	·07235	·21234
6 14	·16070	·16078	·04601	·01516	·09364	·07675	·06154	·02752	·00350	·01208	·07184	·08113	·20084
7 14	·17536	·15757	·03373	·02696	·10411	·08294	·08479	·03449	·02015	·00399	·08981	·10173	·22159
8 14	·20520	·15368	·04500	·02167	·10865	·07988	·10475	·04300	·02362	·01636	·08800	·12307	·21368
9 14	·20657	·19246	·07625	·03517	·10904	·09810	·13410	·05296	·03449	·02656	·11062	·15539	·26692
10 14	·19836	·19404	·09328	·03143	·14702	·11002	·13666	·08366	·03701	·04132	·11879	·15747	·27539
11 14	·20034	·25513	·10717	·03938	·18223	·14828	·13906	·07902	·05143	·04423	·13449	·19919	·28998
12 14	·21290	·26302	·11671	·03046	·18821	·14742	·15290	·09756	·05606	·05432	·12179	·21022	·28420
13 14	·23263	·27364	·11455	·06606	·19138	·18673	·17710	·09129	·05413	·04594	·13387	·21219	·28218
14 14	·25531	·24264	·08644	·04471	·20743	·19462	·16009	·10793	·05471	·04526	·11833	·18331	·27394
15 14	·27065	·22896	·08726	·05573	·20927	·17514	·15184	·11147	·03500	·03933	·11317	·20155	·31023
16 14	·30010	·28883	·05137	·04507	·21730	·16751	·14498	·12078	·04409	·01966	·13427	·24479	·34395
17 14	·31561	·29336	·04745	·05875	·21240	·20459	·15545	·10362	·03924	·03186	·15298	·24479	·35046
18 14	·35546	·27997	·07006	·07009	·17240	·17125	·17093	·09928	·03238	·03722	·14050	·20820	·37407
19 14	·34567	·30838	·06239	·04900	·12992	·15916	·18604	·11556	·02650	·05421	·11187	·24018	·44936
20 14	·32861	·31061	·06199	·05144	·14814	·14933	·16027	·10519	·03592	·03631	·10376	·18511	·45334
21 14	·30456	·24656	·06203	·04597	·15336	·12481	·15761	·09289	·03223	·04070	·14011	·16890	·44184
22 14	·27212	·23306	·06088	·05382	·13774	·14753	·10607	·09519	·04008	·02474	·11930	·19103	·44212
23 14	·25970	·25729	·06041	·04781	·13662	·12694	·11242	·09198	·03650	·01984	·10342	·17233	·32768

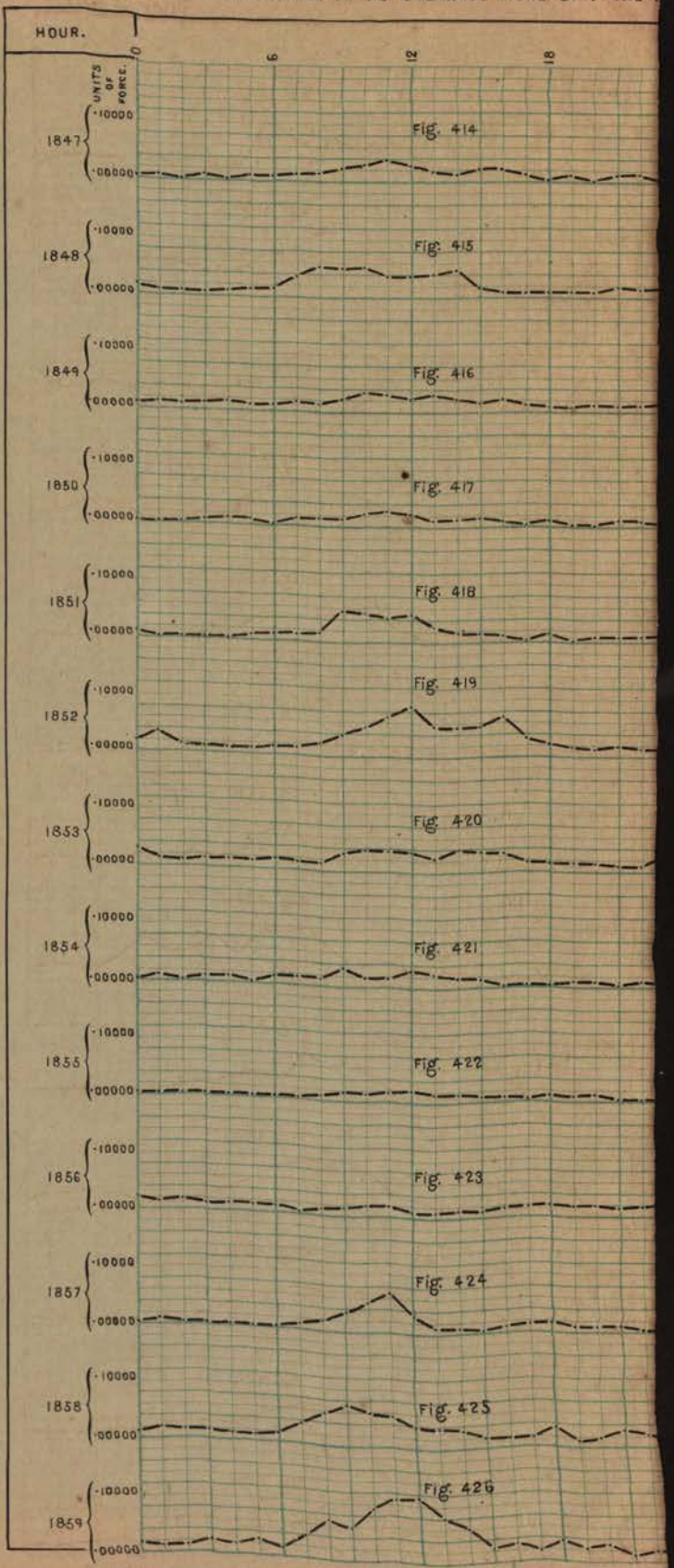
TABLE 93—*continued.*

Bombay Civil Hours.	Aggregate of Southerly Disturbances.											
	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h. m.													
0 14	·26552	·15037	·16610	·05010	·06921	·09739	·08710	·04656	·06756	·19668	·28292	·23045	·31600
1 14	·24460	·16015	·14064	·05193	·06188	·08127	·07250	·02372	·05255	·18254	·28798	·19734	·27472
2 14	·18317	·13461	·11597	·03325	·04973	·08731	·08339	·01808	·05680	·20036	·26922	·19613	·21976
3 14	·18973	·10397	·10126	·03008	·02531	·06786	·04745	·00382	·03384	·17319	·21681	·18254	·21559
4 14	·17189	·09173	·10160	·03703	·04007	·05512	·05265	·01244	·03422	·14388	·19360	·15966	·20862
5 14	·18317	·12399	·10188	·01729	·03519	·04692	·04623	·01753	·01755	·12408	·19145	·15526	·21477
6 14	·19237	·10420	·10316	·02063	·02991	·05551	·04739	·02472	·01816	·12859	·17572	·16247	·20417
7 14	·18866	·11208	·10043	·02541	·04323	·04393	·04728	·01786	·02280	·14740	·19233	·17369	·19127
8 14	·19332	·10655	·11597	·06105	·08059	·07324	·05054	·02660	·04764	·15664	·23831	·19574	·19369
9 14	·23517	·10845	·16097	·07673	·11350	·10144	·09318	·05381	·11945	·18419	·25883	·22258	·25441
10 14	·22788	·14981	·18838	·07695	·13148	·14238	·07051	·08046	·14943	·23149	·28512	·24678	·31079
11 14	·22939	·15904	·19879	·06533	·14874	·15501	·10750	·06520	·18956	·22621	·29293	·23314	·32753
12 14	·25195	·14774	·20893	·10075	·15845	·14803	·12232	·06520	·20827	·21516	·32257	·28088	·33225
13 14	·28016	·15389	·19863	·10436	·17860	·13124	·09993	·06000	·17233	·22484	·33203	·27335	·32726
14 14	·26715	·13494	·19166	·13427	·16794	·13878	·09937	·07360	·13281	·20234	·36206	·24948	·31051
15 14	·25413	·15708	·19283	·17114	·16506	·12814	·10490	·08361	·17300	·21444	·38142	·25118	·33385
16 14	·27147	·15909	·25009	·13555	·16395	·19767	·12299	·06437	·17349	·21444	·44852	·24310	·32869
17 14	·31214	·14964	·25360	·11910	·16178	·16365	·12420	·06553	·18216	·19624	·45760	·22902	·34384
18 14	·34614	·18100	·23611	·12382	·17932	·20315	·13101	·06885	·15622	·20091	·41030	·23969	·32984
19 14	·33217	·19235	·21829	·11348	·15235	·19523	·15086	·04131	·13491	·22742	·41112	·25536	·30283
20 14	·30333	·20292	·20364	·12744	·15967	·19911	·12116	·03423	·14208	·24134	·40491	·25580	·27719
21 14	·27354	·15104	·17534	·08963	·11766	·18781	·10540	·04053	·11526	·23116	·42361	·24871	·27686
22 14	·29211	·17480	·16743	·08056	·10445	·12991	·07454	·04595	·10118	·23892	·38456	·23875	·23217
23 14	·29408	·16021	·15457	·04298	·08319	·10387	·05088	·03617	·07612	·20064	·37917	·18859	·22421

Curves representing these aggregates are numbered 440 to 465 on Plate XXIV.

COLABA OBSERVATORY,—DISTU

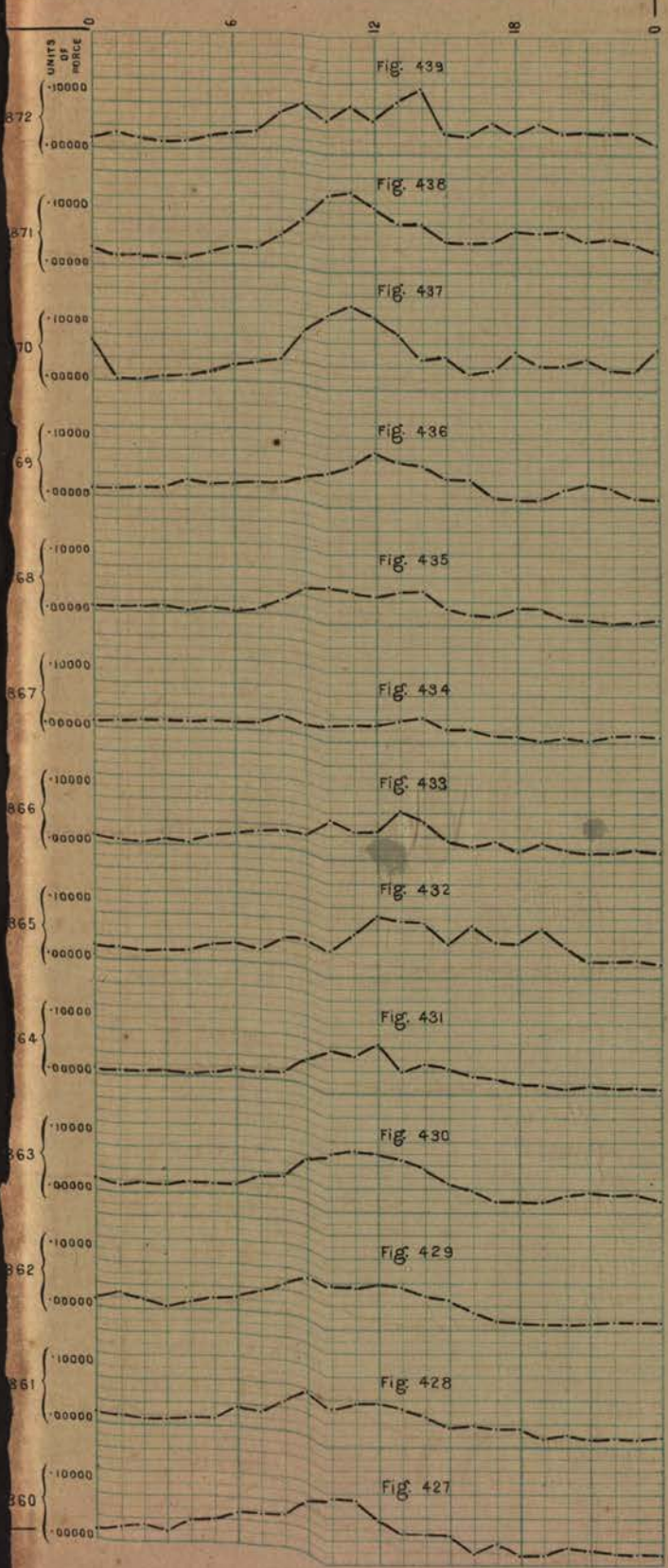
AGGREGATES OF DISTURBANCES INCREASING THE H



NCES OF HORIZONTAL FORCE.

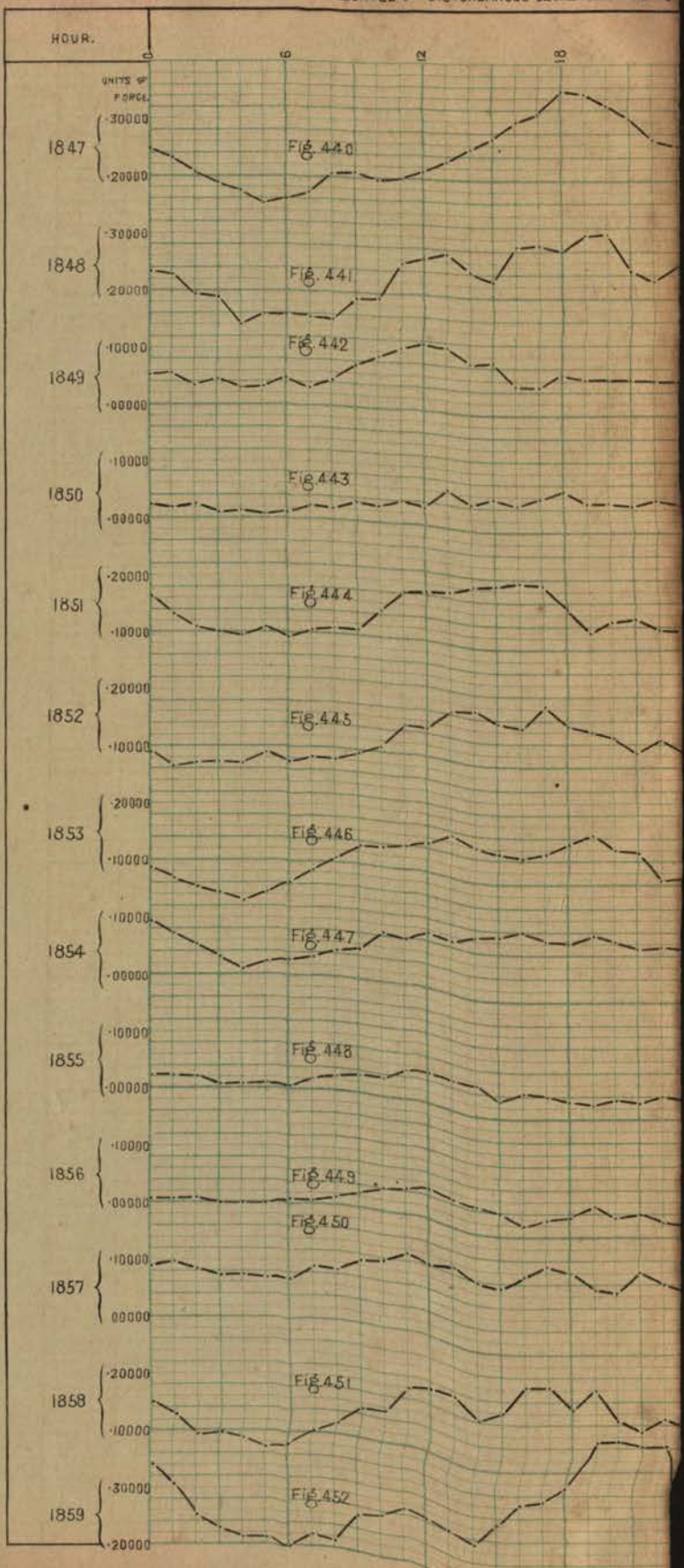
L FORCE IN EACH YEAR:- DIURNAL VARIATION.

Plate XXIII.



COLABA OBSERVATORY,—DISTU

AGGREGATES OF DISTURBANCES DECREASING THE HOR



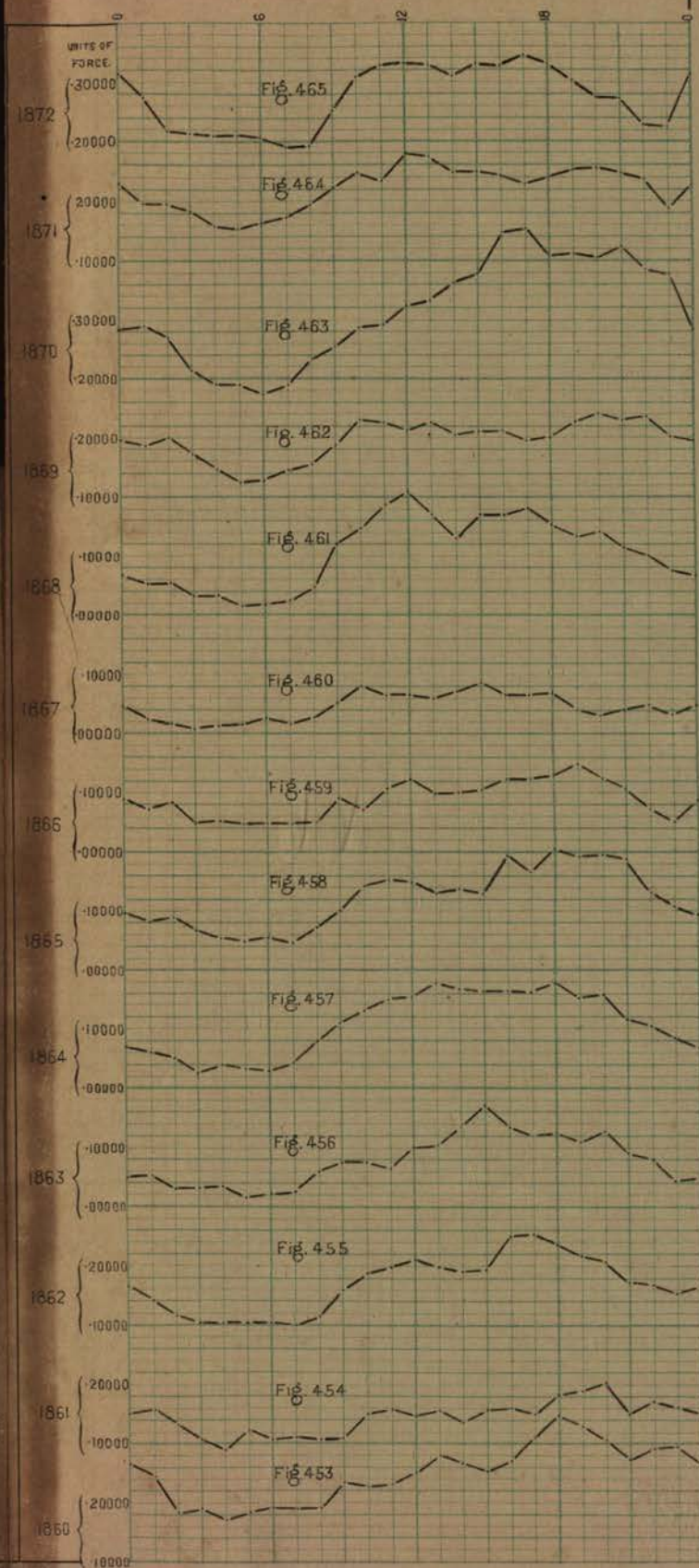

0
6
12
18
0
UNITS OF FORCE.
1872
·30000
·20000
Fig. 465
1871
·20000
·10000
Fig. 464
1870
·30000
·20000
Fig. 463
1869
·20000
·10000
Fig. 462
1868
·10000
·00000
Fig. 461
1867
·10000
·00000
Fig. 460
1866
·10000
·00000
Fig. 459
1865
·10000
·00000
Fig. 458
1864
·10000
·00000
Fig. 457
1863
·10000
·00000
Fig. 456
1862
·20000
·10000
Fig. 455
1861
·20000
·10000
Fig. 454
1860
·20000
·10000
Fig. 453

TABLE 94.—*Showing, for each hour of the day and for the whole day,* (1) *the aggregates of Northerly and of Southerly disturbances, including and excluding the separating value,* (2) *the same in terms of the average aggregates for the twenty-four hours,* (3) *the number of observations separated as disturbed,* (4) *the algebraical sum of all the disturbances, those to the northward being reckoned as positive and those to the southward as negative, and* (5) *the average disturbance per day,—all being derived from the observations of the years* 1847 *to* 1872.

Bombay Civil Hours.	Northerly Disturbances.					Southerly Disturbances.					Northerly *minus* Southerly Disturbances.	
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.	
	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Average disturbance *per* day. Column 12 ÷ 7939.
1	2	3	4	5	6	7	8	9	10	11	12	13
h. m.												
0 14	0·32166	0·49	74	·07450	0·51	3·64864	0·96	550	1·81164	0·99	−3·32698	−·000419
1 14	0·28491	0·44	69	·05445	0·37	3·29128	0·87	513	1·57786	0·86	−3·00637	−·000379
2 14	0·20479	0·42	49	·04113	0·28	2·86830	0·76	452	1·35862	0·74	−2·66351	−·000335
3 14	0·20165	0·31	49	·03799	0·26	2·49794	0·66	398	1·16862	0·64	−2·29629	−·000289
4 14	0·22856	0·35	52	·05488	0·38	2·27326	0·60	374	1·02410	0·56	−2·04470	−·000258
5 14	0·29076	0·45	69	·06030	0·41	2·26836	0·60	372	1·02588	0·56	−1·97760	−·000249
6 14	0·38416	0·59	91	·08022	0·55	2·27849	0·60	386	0·98925	0·54	−1·89433	−·000239
7 14	0·50243	0·77	117	·11165	0·77	2·44359	0·64	417	1·05081	0·57	−1·94116	−·000245
8 14	0·78229	1·20	183	·17107	1·18	2·76644	0·73	466	1·21000	0·66	−1·98415	−·000250
9 14	1·19660	1·84	278	·26808	1·84	3·48134	0·92	581	1·54080	0·84	−2·28474	−·000288
10 14	1·44499	2·22	324	·36283	2·49	3·91591	1·03	654	1·73155	0·94	−2·47092	−·000311
11 14	1·53451	2·36	347	·37553	2·58	4·26830	1·12	672	2·02382	1·10	−2·73379	−·000344
12 14	1·45802	2·24	335	·33912	2·33	4·49827	1·18	703	2·15025	1·17	−3·04025	−·000383
13 14	1·23200	1·90	281	·29346	2·02	4·59831	1·21	724	2·18015	1·19	−3·36631	−·000424
14 14	1·12436	1·73	260	·25596	1·76	4·43963	1·17	688	2·14171	1·17	−3·31527	−·000418
15 14	0·73947	1·14	175	·15497	1·06	4·60038	1·21	711	2·22564	1·21	−3·86091	−·000486
16 14	0·63226	0·97	151	·12792	0·88	4·89612	1·29	753	2·38110	1·30	−4·26386	−·000537
17 14	0·49684	0·76	115	·11274	0·77	4·96906	1·31	744	2·48410	1·35	−4·47222	−·000563
18 14	0·50922	0·78	119	·11176	0·77	4·98817	1·31	727	2·55999	1·40	−4·47895	−·000564
19 14	0·44986	0·69	107	·09248	0·64	4·96592	1·31	714	2·58116	1·41	−4·51606	−·000569
20 14	0·42868	0·66	102	·08800	0·60	4·80284	1·26	702	2·45816	1·34	−4·37416	−·000551
21 14	0·41267	0·63	101	·07533	0·52	4·44812	1·17	641	2·30718	1·26	−4·03545	−·000508
22 14	0·37788	0·58	92	·07060	0·49	4·18901	1·10	613	2·14159	1·17	−3·81113	−·000480
23 14	0·36215	0·56	85	·07825	0·54	3·74762	0·99	549	1·91396	1·04	−3·38547	−·000426
Total...	15·60072	...	3625	3·49322	...	91·14530	—	14104	44·03794	...	.....	.....
Mean...	0·65003	...	...	0·14555	...	3·79772	...	...	1·83491	...	.....	.....

The numbers in columns 3 and 8 are curved in Figs. 466 and 467, those in columns 6 and 11 in Figs. 472 and 473, and those in column 13 in Fig. 478 (Plate XXV).

TABLE 95.—*Showing, for each month and for the whole year,* (1) *the aggregates of Northerly and of Southerly disturbances, including and excluding the separating value,* (2) *the same in terms of the average for the twelve months, and* (3) *the numbers of observations separated as disturbed,—all being derived from the observations of the years* 1847 *to* 1872.

Months.	Northerly Disturbances.					Southerly Disturbances.					Northerly plus Southerly Disturbances.				
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.	
	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
January ...	1·44888	1·11	330	·34668	1·19	5·44785	0·72	946	2·28821	0·62	6·89673	0·78	1276	2·63489	0·67
February ...	1·34921	1·04	318	·28709	0·99	9·73136	1·28	1445	4·90506	1·34	11·08057	1·25	1763	5·19215	1·31
March ...	1·37746	1·06	316	·32202	1·11	6·92370	0·91	1136	3·12946	0·85	8·30116	0·93	1452	3·45148	0·87
April ...	1·39106	1·07	316	·33562	1·15	8·69425	1·14	1329	4·25539	1·16	10·08531	1·13	1645	4·59101	1·16
May ...	0·86500	0·67	203	·18698	0·64	5·61088	0·74	965	2·38776	0·65	6·47586	0·73	1168	2·57474	0·65
June ...	1·28019	0·98	292	·30491	1·05	3·99915	0·53	725	1·57765	0·43	5·27934	0·59	1017	1·88256	0·48
July ...	1·11358	0·86	262	·23850	0·82	5·06397	0·67	858	2·19825	0·60	6·17755	0·69	1120	2·43675	0·62
August ...	1·42765	1·10	330	·32545	1·12	6·98507	0·92	1106	3·29103	0·90	8·41272	0·95	1436	3·61648	0·91
September..	1·44177	1·11	330	·33957	1·17	10·91373	1·44	1558	5·71001	1·56	12·35550	1·39	1888	6·04958	1·53
October ...	1·84690	1·42	435	·39400	1·35	13·07067	1·72	1784	7·11211	1·94	14·91757	1·68	2219	7·50611	1·90
November ..	1·42718	1·10	340	·29158	1·00	6·95325	0·92	1145	3·12895	0·85	8·38043	0·94	1485	3·42053	0·86
December..	0·63047	0·48	153	·11945	0·41	7·75030	1·02	1107	4·05292	1·10	8·38077	0·94	1260	4·17237	1·05
Total ...	15·59935	...	3625	3·49185	...	91·14416	...	14104	44·03680	...	106·74351	...	17729	47·52865	...
Mean ...	1·29995	...	...	·29099	...	7·59535	...	...	3·66973	...	8·89529	...	...	3·96072	...

The numbers in columns 3 and 8 are curved in Figs. 468 and 469, those in columns 6 and 11 in Figs. 474 and 475, and those in columns 13 and 16 in Figs. 479 and 480 (Plate XXV).

TABLE 96.—*Showing, for the years* 1847 *to* 1872, *and for the whole period,* (1) *the aggregates of Northerly and of Southerly disturbances, including and excluding the separating value,* (2) *the same in terms of the average yearly aggregate, and* (3) *the number of observations separated as disturbed.*

Years.	Northerly Disturbances.					Southerly Disturbances.					Northerly plus Southerly Disturbances.				
	Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.		Including separating value.			Excluding separating value.	
	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.	Aggregates.	Ratios.	Number of disturbed observations.	Aggregates.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1847 ...	·25243	0·42	50	·08543	0·64	5·80940	1·66	709	3·44134	2·03	6·06183	1·48	759	3·52677	1·93
1848 ...	·46994	·78	113	·09252	·69	5·50234	1·57	824	2·75018	1·62	5·97228	1·45	937	2·84270	1·56
1849 ...	·31793	·53	75	·06743	·50	1·55012	·44	320	·48132	·28	1·86805	·45	395	·54875	·30
1850 ...	·17042	·28	43	·02680	·20	·89715	·26	187	·27257	·16	1·06757	·26	230	·29937	·16
1851 ...	·30459	·51	71	·06745	·50	3·56297	1·02	560	1·69257	1·00	3·86756	·94	631	1·76002	·96
1852 ...	·69134	1·15	152	·18366	1·37	3·01523	·86	477	1·42205	·84	3·70657	·90	629	1·60571	·88
1853 ...	·45048	·75	109	·08643	·64	2·82890	·81	476	1·23906	·73	3·27938	·80	585	1·32548	·73
1854 ...	·20120	·34	49	·03754	·28	1·85424	·53	332	·74536	·44	2·05544	·50	381	·78290	·43
1855 ...	·10335	·17	23	·02653	·20	·75338	·21	157	·22900	·14	·85673	·21	180	·25553	·14
1856 ...	·26660	·44	60	·06620	·49	·62044	·18	125	·20294	·12	·88704	·22	185	·26914	·15
1857 ...	·23680	·39	54	·05644	·42	2·59735	·74	384	1·31479	·78	2·83415	·69	438	1·37123	·75
1858 ...	·59880	1·00	144	·11784	·88	3·92201	1·12	617	1·86123	1·10	4·52081	1·10	761	1·97907	1·08
1859 ...	·85462	1·42	201	·18328	1·36	7·36181	2·10	935	4·23891	2·50	8·21643	2·00	1136	4·42219	2·42
1860 ...	·94555	1·58	210	·24415	1·82	5·98321	1·71	862	3·19413	1·83	6·92876	1·69	1072	3·34828	1·83
1861 ...	·72916	1·22	169	·16470	1·23	3·46971	·99	599	1·48605	·87	4·19887	1·02	768	1·63375	·89
1862 ...	·70994	1·18	160	·17554	1·31	4·04631	1·15	640	1·90871	1·13	4·75625	1·16	800	2·08428	1·14
1863 ...	·90011	1·50	213	·18869	1·40	1·88886	·54	353	·70984	·42	2·78897	·68	566	·89853	·49
1864 ...	·53034	·88	126	·10950	·82	2·62115	·75	474	1·03799	·61	3·15149	·77	600	1·14749	·63
1865 ...	1·09520	1·83	250	·26020	1·94	2·93397	·84	544	1·11701	·66	4·02917	·98	794	1·37721	·75
1866 ...	·60000	1·00	141	·12906	·96	2·11327	·60	356	·92423	·55	2·71327	·66	497	1·05329	·58
1867 ...	·35698	·59	87	·06640	·49	1·07016	·31	223	·32534	·19	1·42714	·35	390	·39174	·21
1868 ...	·47067	·78	113	·09325	·69	2·57731	·74	451	1·07097	·63	3·04798	·74	564	1·16422	·64
1869 ...	·83601	1·39	205	·15131	1·13	4·70253	1·34	757	2·17415	1·28	5·53854	1·35	962	2·32546	1·27
1870 ...	1·18839	1·98	281	·24985	1·86	7·60242	2·17	1027	4·17224	2·46	8·79081	2·14	1308	4·42209	2·42
1871 ...	1·30959	2·18	287	·35101	2·61	5·30915	1·51	855	2·45345	1·45	6·61874	1·61	1142	2·80446	1·53
1872 ...	1·00891	1·68	239	·21065	1·57	6·55077	1·87	860	3·67837	2·17	7·55968	1·84	1099	3·88902	2·13
Total ..	15·59935	...	3625	3·49185	...	91·14416	...	14104	44·03680	...	106·74351	...	17729	47·52865	...
Mean ..	·59997	...	...	·13430	...	3·50554	...	..	1·69372	...	4·10552	...	...	1·82802	...

The numbers in columns 3 and 8 are curved in Figs. 470 and 471, those in columns 6 and 11 in Figs. 476 and 477, and those in columns 13 and 16 in Figs. 481 and 482 (Plate XXV).

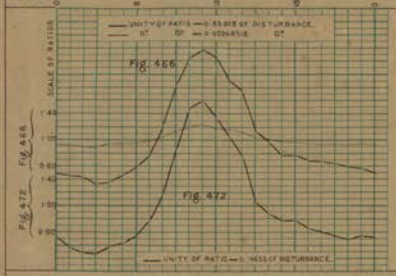
COLABA OBSERVATORY.— DISTURBANCES OF HORIZONTAL FORCE.

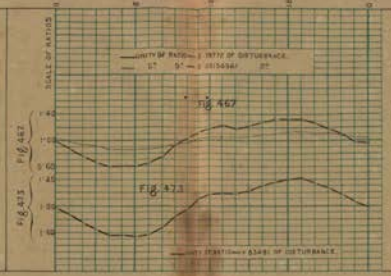
—UPPER STRONG LINES REPRESENT RATIOS OF LARGER DISTURBANCES.—CALCULATED TOTAL DISTURBANCE PER DAY.—LOWER STRONG LINES REPRESENT RATIOS OF THAT PART ONLY OF DISTURBANCES WHICH IS IN EXCESS OF ·00334 Plate XXV.

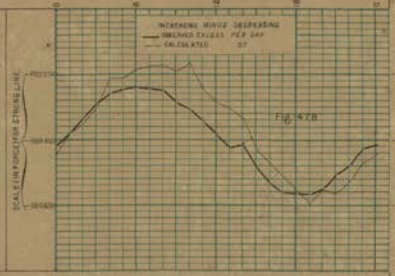
DISTURBANCES INCREASING HORIZONTAL FORCE. | DISTURBANCES DECREASING HORIZONTAL FORCE.

DIURNAL VARIATION.

HOUR.

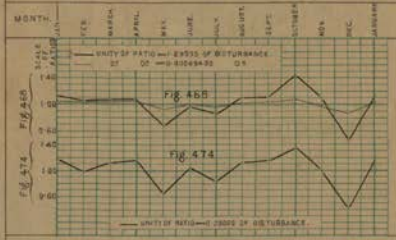


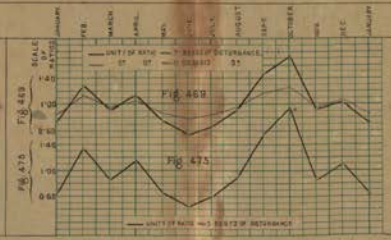


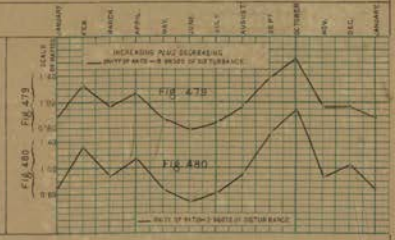


ANNUAL VARIATION

MONTH.

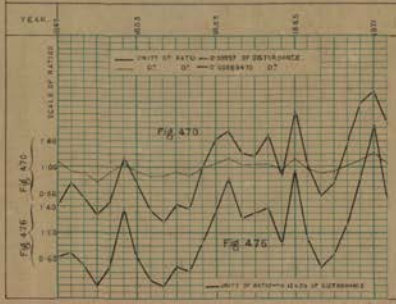


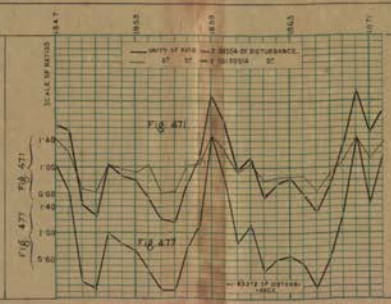


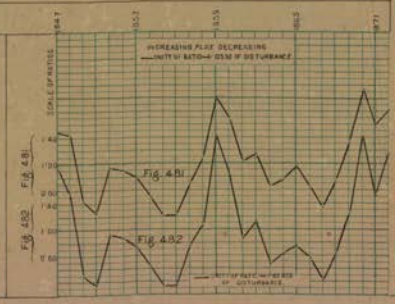


SECULAR VARIATION

YEAR.







224. *Remarks on the disturbance variations.*—The most striking feature about the horizontal force disturbances is the great frequency and magnitude of disturbances in the direction of a diminishing force, and the comparative rarity of those of the opposite sign. The total number of the former (14,104) in the twenty-six years is nearly four times as great as the number (3625) of the latter; and whilst the average excess of the former above the separating value (·00334) is ·003122, that of the latter is only ·000963. In the case of the declination the corresponding numbers for twenty-seven years, the separating value being ·00150, were—of easterly disturbances 6916 with an average excess of ·000721, and of westerly disturbances 4709 with an average excess of ·000558; so that—allowing for the difference in the two separating values—the southerly disturbances are seen to preponderate largely over those in the direction west, north or east, and even to exceed all these taken together. And when we look at the aggregates of actual disturbance—91·14416 for the southerly disturbances, and 40·62484 for the westerly, northerly and easterly taken together—we find that the preponderance is still more marked than in the numbers. It follows from these facts that disturbance in the horizontal plane at Bombay consists mainly of casual outbreaks of south-magnetic force followed in each case by a return to the normal state of things after a more or less prolonged interval of disturbance.

225. The diurnal variation curve of north disturbance (Fig. 466) is of intermediate character between those of east and west disturbance (Figs. 151 and 152), having the same hours of great preponderance, an intermediate range of the ratios, and an intermediate prevalency of disturbance during the night hours. That of southerly disturbance is quite different from these, having a maximum of disturbance about 18 hours, a minimum about 5 or 6 hours, and a motion of a simple wave type between each and the other. In the annual variation curve of north disturbance (Fig. 468) there is, as in that of east disturbance (Fig. 153), a tendency towards a double period, the maxima occurring near the equinoxes; a more decided tendency of the same kind appears in the curve of south disturbance (Fig. 469) which represents a much larger body of disturbed observations.

226. Also here, as in the corresponding declination curves (Figs. 178 and 179), the sun-spot period is strongly marked in the secular variation curve (Fig. 494) of south disturbance, the years of maximum being 1847-48, 1859 and 1870-72 and the years of minimum 1856 and 1867. The two minima and the two later maxima are also distinctly shown by the curve (Fig. 493) of secular variation of north disturbance, and the absence of a maximum at 1847 is partly accounted for by the observations of the first five months of that year being only half as many as usual: the presence in this curve of two erratic points at 1852 and 1865—counterparts of which appear also in the curve of south disturbance—would have some significance if it were not for the overwhelming flow of the latter curve which stands by its side. The ratios of south disturbance for the maximum and minimum years, in order, are 1·61, 0·18, 2·10, 0·31 and 1·85; in other words, the disturbance at the average maximum time is about eight times as great as the disturbance at the average minimum time. The disturbance diurnal variation (Fig. 478—strong line) is, on account of the overpowering frequency and magnitude of south disturbance, substantially the reverse of the curve of south disturbance. On the whole the proportion of north disturbance to south disturbance, in the twenty-six years, is as 1 to 5·8.

227. Variations of disturbance ratios including and excluding the separating value, are shown in the curves of Figs. 466 to 477: the significance of the approach to identity of form in the pairs of diurnal and annual variation curves, both of north and south disturbance, has been explained in paragraph 141: the similar approach, though marked, is less complete in the two pairs of secular variation curves.

228. Hourly, monthly and yearly totals of north and south disturbance, calculated in the manner described in paragraphs 142 and 143, are shown in Tables 97 to 99 and by the curves of Figs. 483 to 488 on Plate XXVI; and so also are the aggregates of disturbances that exceed the separating value and aggregates of disturbances that are in defect of the separating value, these two together making up the calculated totals.

TABLE 97.

Disturbance diurnal variations.

Bombay Civil Hours.	NORTHERLY. $A = 7939$.								SOUTHERLY.								Excess of Northerly over Southerly disturbance. Column 8 minus Column 16.
	n_r	$\left(1-\frac{m_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.	n_r	$\left(1-\frac{m_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
h. m.																	
0 14	74	·981	1·66	0·32166	5·0598	4·7381	·00063732	0·92	550	·861	1·05	3·64864	10·9883	7·3397	·00138408	1·03	—·00074676
1 14	69	·983	1·69	0·28491	4·9555	4·6706	·00062419	0·91	513	·871	1·07	3·29128	10·3414	7·0501	·00130260	0·97	—·00067841
2 14	49	·988	1·78	0·20479	4·8675	4·6627	·00061311	0·89	452	·886	1·12	2·86830	10·0552	7·1869	·00126654	0·94	—·00065343
3 14	49	·988	1·78	0·20165	4·7929	4·5913	·00060371	0·88	398	·900	1·16	2·49794	9·5931	7·0952	·00120834	0·90	—·00060463
4 14	52	·987	1·76	0·22856	5·0613	4·8327	·00063751	0·93	374	·906	1·18	2·27326	9·1487	6·8754	·00115236	0·85	—·00051485
5 14	69	·983	1·69	0·29076	5·0572	4·7664	·00063700	0·92	372	·906	1·18	2·26836	9·1289	6·8605	·00114987	0·85	—·00051287
6 14	91	·977	1·61	0·38416	5·1313	4·7471	·00064634	0·94	386	·903	1·17	2·27849	8·9567	6·6782	·00112818	0·84	—·00048184
7 14	117	·971	1·54	0·50243	5·3832	4·8808	·00067806	0·98	417	·895	1·15	2·44359	9·1702	6·7266	·00115507	0·86	—·00047701
8 14	183	·954	1·41	0·78229	5·7119	4·9296	·00071947	1·04	466	·883	1·11	2·76644	9·4844	6·7180	·00119465	0·89	—·00047518
9 14	278	·930	1·28	1·19660	6·1587	4·9621	·00077575	1·13	581	·854	1·03	3·48134	10·0575	6·5762	·00126683	0·94	—·00049108
10 14	324	·918	1·23	1·44499	6·5599	5·1149	·00082629	1·20	654	·835	0·98	3·91591	10·2310	6·3151	·00128869	0·95	—·00046240
11 14	347	·913	1·21	1·53451	6·6345	5·1000	·00083568	1·21	672	·831	0·97	4·26830	10·9363	6·6680	·00137753	1·02	—·00054185
12 14	335	·916	1·22	1·45802	6·4589	5·0009	·00081356	1·18	703	·823	0·95	4·49827	11·0917	6·5934	·00139711	1·04	—·00058355
13 14	281	·929	1·28	1·23200	6·3409	5·1089	·00079869	1·16	724	·818	0·94	4·59831	11·1260	6·5277	·00140142	1·04	—·00060273
14 14	260	·935	1·30	1·12436	6·0934	4·9690	·00076752	1·11	688	·827	0·96	4·43963	11·1581	6·7185	·00140546	1·04	—·00063794
15 14	175	·956	1·42	0·73947	5·5542	4·8147	·00069960	1·02	711	·821	0·95	4·60038	11·3433	6·7429	·00142879	1·06	—·00072919
16 14	151	·962	1·47	0·63226	5·4873	4·8550	·00069118	1·00	753	·810	0·93	4·89612	11·6271	6·7310	·00146454	1·09	—·00077336
17 14	115	·971	1·54	0·49684	5·3233	4·8265	·00067052	0·97	744	·813	0·93	4·96906	11·8002	6·8311	·00148635	1·10	—·00081583
18 14	119	·970	1·53	0·50922	5·2910	4·7818	·00066645	0·97	727	·817	0·94	4·98817	12·0692	7·0810	·00152023	1·13	—·00085378
19 14	107	·973	1·56	0·44986	5·1283	4·6784	·00064595	0·94	714	·820	0·95	4·96592	12·2447	7·2788	·00154234	1·14	—·00089639
20 14	102	·974	1·57	0·42868	5·0421	4·6134	·00063510	0·92	702	·823	0·95	4·80284	11·8427	7·0399	·00149164	1·11	—·00085659
21 14	101	·975	1·58	0·41267	5·0091	4·5964	·00063094	0·92	641	·839	0·99	4·44812	11·8530	7·4049	·00149300	1·11	—·00086206
22 14	92	·977	1·61	0·37788	5·0474	4·6695	·00063577	0·92	613	·846	1·01	4·18901	11·6180	7·4290	·00146339	1·08	—·00082762
23 14	85	·979	1·63	0·36215	5·1613	4·7992	·00065011	0·94	549	·862	1·05	3·74762	11·2865	7·5389	·00142164	1·05	—·00077153
Mean...							·00068916								·00134961		

The numbers in columns 6 and 14 are curved in Figs. 483 and 484, those in columns 7 and 15 in Figs. 495 and 496, those in columns 5 and 13 in Figs. 489 and 490 (Plate XXVI), those in column 18 in Fig. 478 (thin line), and those in columns 9 and 17 in Figs. 466 and 467 (Plate XXV), the last being in thin lines to distinguish them from the ratios of ΣE_r.

TABLE 98.

Disturbance annual variations.

Month.	NORTHERLY.								A	SOUTHERLY.							
	n_r	$\left(1-\frac{m_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.		n_r	$\left(1-\frac{m_r}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ac}{2\sqrt{\pi}} - \Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.
1	2	3		5	6	7	8	9	10	11	12	13	14	15	16	17	18
January ...	330	·959	1·44	1·44888	11·5231	10·0742	·00071341	1·03	16152	946	·883	1·11	5·44785	18·6775	13·2297	·00115635	0·86
February ...	318	·957	1·43	1·34921	10·4270	9·0778	·00069849	1·01	14928	1445	·806	0·92	9·73136	22·6856	12·9542	·00151967	1·13
March ...	316	·960	1·45	1·37746	11·2764	9·8989	·00071189	1·03	15840	1136	·857	1·04	6·92370	20·4207	13·4970	·00128917	0·96
April ...	316	·960	1·45	1·39106	11·3878	9·9967	·00072552	1·04	15696	1329	·831	0·97	8·69425	22·2767	13·5825	·00141925	1·06
May ...	203	·975	1·58	0·86500	10·4998	9·6348	·00064622	0·93	16248	965	·881	1·10	5·61086	18·8157	13·2048	·00115803	0·86
June ...	292	·963	1·47	1·28019	11·1104	9·8302	·00069615	1·00	15960	725	·909	1·20	3·99915	16·8791	12·8800	·00105760	0·79
July ...	262	·968	1·52	1·11358	11·2228	10·1092	·00068165	0·98	16464	858	·896	1·15	5·06397	19·0038	13·9398	·00115425	0·86
August ...	330	·959	1·44	1·42765	11·3543	9·9267	·00070192	1·01	16176	1106	·863	1·05	6·98507	21·0363	14·0512	·00130047	0·97
September.	330	·959	1·44	1·44177	11·4607	10·0249	·00071738	1·03	15984	1558	·805	0·92	10·91373	25·4419	14·5282	·00159170	1·19
October ...	435	·947	1·37	1·84690	12·0659	10·2190	·00074152	1·07	16272	1784	·781	0·87	13·07067	27·8618	14·7911	·00171226	1·27
November.	340	·956	1·42	1·42718	10·7196	9·2924	·00068821	0·99	15576	1145	·853	1·03	6·95325	20·0877	13·1345	·00128964	0·96
December.	153	·980	1·64	0·63047	9·2839	8·6534	·00060919	0·88	15240	1107	·855	1·03	7·75030	22·3903	14·6400	·00146920	1·09
Mean...							·00069430									·00134313	

The numbers in columns 6 and 15 are curved in Figs. 485 and 486, those in columns 7 and 16 in Figs. 497 and 498, those in columns 5 and 14 in Figs. 491 and 492 (Plate XXVI), and those in columns 9 and 18 in Figs. 468 and 469 (Plate XXV), the last being in thin lines to distinguish them from the ratios of ΣE_r.

COLABA OBSERVATORY.—DISTURBANCES OF HORIZONTAL FORCE.

——CALCULATED TOTAL DISTURBANCE: —— OBSERVED LARGER DISTURBANCES: – – – – CALCULATED SMALLER DISTURBANCES.

Plate XXVI.

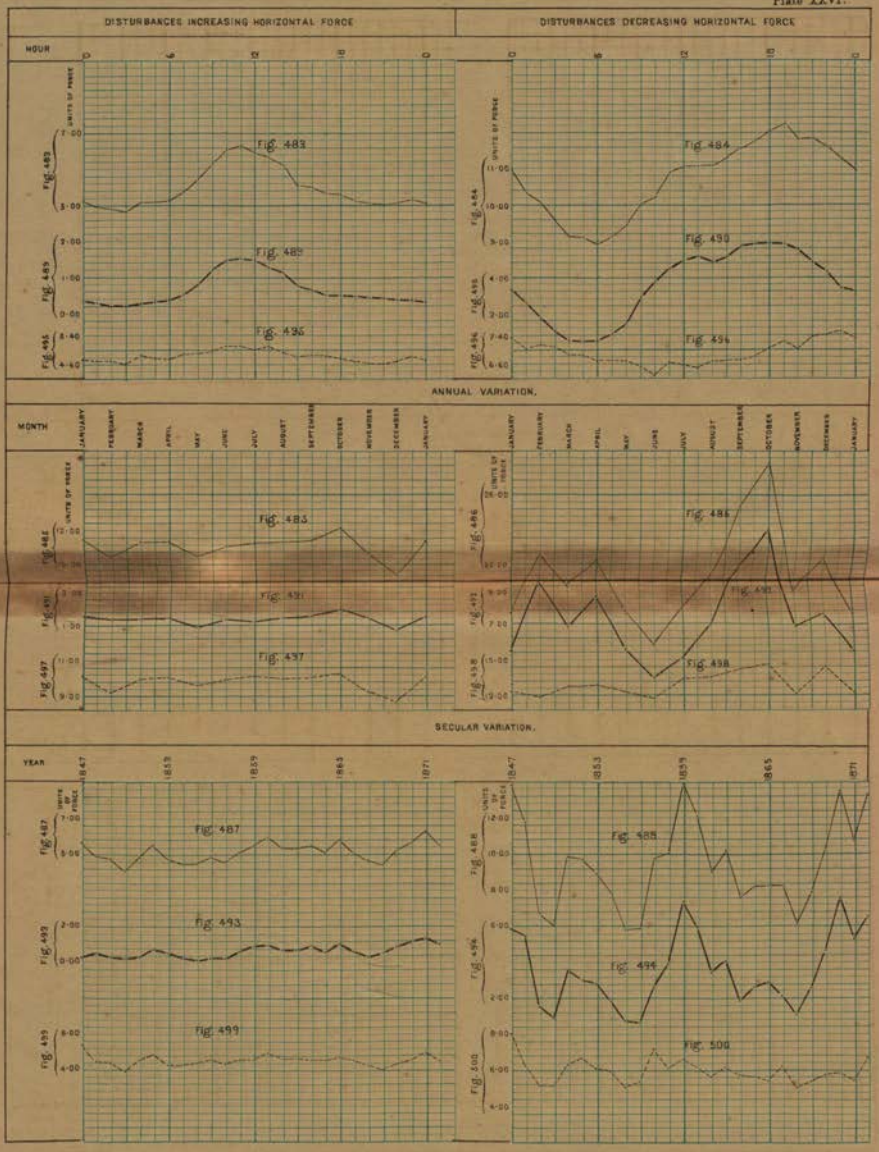


TABLE 99.

Disturbance secular variations.

Year.	NORTHERLY.								A	SOUTHERLY.							
	n_r	$\left(1-\frac{mr}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{\phi}{\frac{Ac}{2\sqrt{\pi}}}$	$\frac{Ao}{2\sqrt{\pi}}-\Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.		n_r	$\left(1-\frac{mr}{A}\right)$	$\frac{C}{c}$	ΣE_r	$\frac{Ac}{2\sqrt{\pi}}$	$\frac{Ao}{2\sqrt{\pi}}-\Sigma E_r$	$\frac{c}{2\sqrt{\pi}}$ Values.	Ratios.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1847 ...	50	·987	1·76	0·25243	5·5808	5·3374	·00074650	1·07	7488	709	·811	0·93	5·80940	13·7959	7·9865	·00184238	1·42
1848 ...	113	·970	1·53	0·46994	4·8828	4·4129	·00065418	0·94	7464	824	·779	0·87	5·50234	11·7290	6·2267	·00157141	1·21
1849 ...	75	·980	1·64	0·31793	4·6817	4·3638	·00062723	0·90	7464	320	·914	1·21	1·55012	6·7021	5·1520	·00089792	0·69
1850 ...	43	·988	1·78	0·17042	4·0506	3·8802	·00054797	0·79	7392	187	·949	1·38	0·89715	6·0246	5·1275	·00081502	0·63
1851 ...	71	·981	1·66	0·30459	4·7913	4·4867	·00065241	0·94	7344	560	·847	1·01	3·56297	9·8817	6·3187	·00134555	1·03
1852 ...	152	·959	1·44	0·69134	5·4983	4·8070	·00073428	1·06	7488	477	·873	1·08	3·01523	9·6801	6·6649	·00129274	0·99
1853 ...	109	·970	1·53	0·45048	4·6807	4·2302	·00064367	0·93	7272	476	·869	1·07	2·82890	8·8887	6·0598	·00122233	0·94
1854 ...	49	·987	1·76	0·20120	4·4554	4·2542	·00066470	0·87	7368	332	·910	1·20	1·85424	7·8262	5·9720	·00133721	1·03
1855 ...	23	·994	1·94	0·10335	4·4545	4·3512	·00060854	0·88	7320	157	·957	1·43	0·75338	5·8222	5·0688	·00079539	0·61
1856 ...	60	·984	1·70	0·26660	4·7969	4·5303	·00064893	0·93	7392	125	·966	1·50	0·62044	5·8864	5·2660	·00079632	0·61
1857 ...	54	·985	1·72	0·23680	4·5623	4·3255	·00061920	0·89	7368	384	·896	1·15	2·59735	9·7472	7·1499	·00132291	1·02
1858 ...	144	·961	1·46	0·59880	5·0467	4·4479	·00069172	1·00	7296	617	·831	0·97	3·92201	10·0492	6·1272	·00137737	1·06
1859 ...	201	·945	1·36	0·85462	5·4329	4·5783	·00074710	1·08	7272	935	·743	0·80	7·36181	13·9614	6·5996	·00191991	1·48
1860 ...	210	·943	1·35	0·94555	5·8502	4·9047	·00079921	1·15	7320	862	·764	0·84	5·98321	12·1163	6·1331	·00165524	1·27
1861 ...	169	·954	1·41	0·72916	5·3239	4·5947	·00072731	1·05	7320	599	·836	0·98	3·46971	9·0653	5·5956	·00123843	0·95
1862 ...	160	·956	1·42	0·70994	5·3324	4·6225	·00073087	1·05	7296	640	·825	0·96	4·04631	10·1695	6·1232	·00139386	1·07
1863 ...	213	·942	1·34	0·90011	5·4214	4·5213	·00073821	1·06	7344	353	·904	1·18	1·88886	7·6017	5·7128	·00123509	0·80
1864 ...	126	·966	1·50	0·53034	5·0315	4·5012	·00068289	0·98	7368	474	·871	1·07	2·62115	8·2359	5·6148	·00111779	0·86
1865 ...	250	·932	1·29	1·09520	5·7835	4·6883	·00079010	1·14	7320	544	·851	1·02	2·93397	8·3042	5·3702	·00113446	0·87
1866 ...	141	·961	1·46	0·60000	5·0568	4·4568	·00060311	1·00	7296	356	·902	1·17	2·11327	8·3073	6·1940	·00113862	0·88
1867 ...	87	·976	1·60	0·35698	4·6176	4·2606	·00063201	0·91	7296	223	·939	1·32	1·07016	6·1117	5·0415	·00083768	0·64
1868 ...	113	·966	1·50	0·47067	4·4655	3·9948	·00066088	0·96	6696	451	·865	1·06	2·57731	7·9276	5·3503	·00118391	0·91
1869 ...	805	·944	1·35	0·83601	5·1725	4·3365	·00070663	1·02	7320	757	·793	0·89	4·70253	10·3832	5·6807	·00141847	1·09
1870 ...	281	·923	1·25	1·18839	5·6694	4·4810	·00077199	1·11	7344	1027	·720	0·76	7·60242	13·5456	5·9432	·00184446	1·42
1871 ...	287	·922	1·25	1·30959	6·2477	4·9381	·00085351	1·23	7320	855	·766	0·84	5·30915	10·7513	5·4422	·00146876	1·13
1872 ...	239	·935	1·30	1·00891	5·4676	4·4587	·00074208	1·07	7368	860	·767	0·84	6·55077	13·2657	6·7149	·00180045	1·38
Mean...							·00069470									·00130014	

The numbers in columns 6 and 15 are curved in Figs. 487 and 488, those in columns 7 and 16 in Figs. 499 and 500, those in columns 5 and 14 in Figs. 493 and 494 (Plate XXVI), and those in columns 9 and 18 in Figs. 470 and 471 (Plate XXV), the last being in thin lines to distinguish them from the ratios of ΣEr.

229. No remark is called for by the curves of annual and secular variation except that, in the latter, the maximum of 1847, which is missing in the north disturbance curve and defective in the south disturbance curve (Figs. 493 and 494), takes its place, with proper magnitude, in both the curves of total disturbance (Figs. 487 and 488). The diurnal variation curves of north disturbance (Figs. 483, 489 and 495) show that the aggregates of disturbances that keep within the separating value, whilst otherwise varying in the same way as the larger disturbances, are much more nearly equal in amount at all hours of the day. Those of south disturbance (Figs. 484, 490 and 496) indicate that the smaller disturbances follow, not the same law of variation as the larger, but rather vary oppositely to the north disturbances; that is, they occur with greatest effect in the night hours, and with least effect during the day hours, having a minimum a little before noon. This opposition of variation in the smaller north and south disturbances determines, in the curve of disturbance diurnal variation (Fig. 478, thin line), a relative elevation above the thick line curve, representing the larger disturbances alone, during the day hours and a relative depression during the night hours: nevertheless the total disturbance curve depends for much the greater part of its motion upon the larger disturbances.

The thin lines of Figs. 466 to 471 represent ratios of the calculated total disturbances *per* observation—within and without the limit of the separating value, and the thick line curves represent ratios of *aggregates* of the larger disturbances only.

230. Figs. 390 to 465 on Plates XXI to XXIV are constructed to show the extent to which the general character of the diurnal variation of disturbance aggregates is exhibited by individual month's or year's observations: the yearly curves further indicate that the extent of variability of disturbance at different hours follows, like the general aggregates of disturbance, the sun-spot period,—being great when the spotted area is great and small when this is small.

231. *The regular solar-diurnal variation.*—After the separation of disturbed observations differing from the final normals by ·00334 the averages were taken of the monthly final normals of each hour—in the first place for every month, and in the second place for each of the fifty-two half years; and by means of these averages were calculated the diurnal variations* for each month (on an average of twenty-six years) for the whole year, and for each individual half year from 1847 to 1872, the one half year comprising the months April to September, and the other the months January to March and October to December. The diurnal variations are shown in the following tables.

TABLE 100.—*Showing, for the period* 1847 *to* 1872, *the mean diurnal variation of Horizontal Force for each month of the year and for the whole year.*†

Bombay Civil Hours.		January.	February.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
h.	m.													
0	14	−·00164	−·00178	−·00178	−·00179	−·00163	−·00152	−·00143	−·00132	−·00138	−·00137	−·00165	−·00168	−·00158
1	14	−·00142	−·00169	−·00171	−·00171	−·00164	−·00145	−·00145	−·00124	−·00115	−·00136	−·00155	−·00151	−·00149
2	14	−·00138	−·00149	−·00167	−·00164	−·00157	−·00140	−·00139	−·00121	−·00104	−·00121	−·00139	−·00132	−·00139
3	14	−·00126	−·00150	−·00156	−·00151	−·00146	−·00131	−·00134	−·00114	−·00096	−·00120	−·00132	−·00129	−·00132
4	14	−·00117	−·00140	−·00146	−·00144	−·00141	−·00128	−·00123	−·00106	−·00086	−·00112	−·00125	−·00112	−·00124
5	14	−·00101	−·00127	−·00142	−·00146	−·00128	−·00123	−·00113	−·00098	−·00079	−·00100	−·00101	−·00093	−·00113
6	14	−·00077	−·00107	−·00134	−·00140	−·00105	−·00089	−·00083	−·00089	−·00099	−·00092	−·00072	−·00068	−·00097
7	14	−·00055	−·00064	−·00083	−·00076	−·00015	−·00007	−·00013	−·00059	−·00114	−·00077	−·00003	−·00026	−·00050
8	14	+·00045	+·00043	+·00074	+·00094	+·00127	+·00117	+·00103	+·00055	−·00001	+·00075	+·00138	+·00090	+·00079
9	14	+·00176	+·00210	+·00292	+·00305	+·00286	+·00252	+·00242	+·00205	+·00174	+·00252	+·00285	+·00226	+·00241
10	14	+·00306	+·00351	+·00439	+·00447	+·00411	+·00369	+·00357	+·00310	+·00316	+·00387	+·00394	+·00338	+·00368
11	14	+·00371	+·00430	+·00479	+·00477	+·00436	+·00400	+·00396	+·00361	+·00360	+·00451	+·00435	+·00384	+·00415
12	14	+·00361	+·00425	+·00444	+·00423	+·00405	+·00370	+·00372	+·00351	+·00347	+·00414	+·00375	+·00344	+·00385
13	14	+·00292	+·00341	+·00357	+·00312	+·00321	+·00302	+·00297	+·00280	+·00281	+·00292	+·00269	+·00268	+·00301
14	14	+·00201	+·00221	+·00225	+·00200	+·00198	+·00197	+·00185	+·00185	+·00184	+·00145	+·00170	+·00180	+·00190
15	14	+·00122	+·00119	+·00090	+·00089	+·00082	+·00070	+·00075	+·00097	+·00091	+·00059	+·00073	+·00101	+·00088
16	14	+·00049	+·00024	+·00001	+·00006	−·00015	−·00035	−·00035	−·00001	+·00018	−·00021	−·00004	+·00023	·00000
17	14	−·00024	−·00041	−·00071	−·00083	−·00093	−·00109	−·00106	−·00066	−·00041	−·00072	−·00069	−·00048	−·00069
18	14	−·00084	−·00100	−·00127	−·00147	−·00155	−·00150	−·00140	−·00117	−·00092	−·00130	−·00136	−·00103	−·00124
19	14	−·00141	−·00157	−·00178	−·00189	−·00200	−·00183	−·00176	−·00159	−·00148	−·00180	−·00187	−·00150	−·00171
20	14	−·00172	−·00184	−·00208	−·00191	−·00208	−·00190	−·00180	−·00174	−·00165	−·00200	−·00208	−·00181	−·00189
21	14	−·00193	−·00197	−·00226	−·00199	−·00204	−·00176	−·00177	−·00170	−·00169	−·00210	−·00222	−·00197	−·00196
22	14	−·00199	−·00208	−·00211	−·00190	−·00185	−·00169	−·00165	−·00164	−·00164	−·00188	−·00218	−·00201	−·00189
23	14	−·00188	−·00189	−·00193	−·00182	−·00176	−·00159	−·00152	−·00151	−·00149	−·00168	−·00197	−·00184	−·00174

These variations are also represented by the curves of Figs. 501 to 513 (Plate XXVII), which show great similarity of character all the year round. The mean curve for the year has a maximum at 11 hours and a minimum at 21 hours with a range from one to the other of ·00611 : after the minimum there is at first a slow rise till 7 hours followed by a more rapid rise to the time of maximum : the fall after the maximum is at a less rapid rate than the rise before, and there is no abrupt change in the rate of fall corresponding to that which occurs in the rate of *rise* about 7 hours. These characteristics are, it will be observed, altogether unlike those of the mean diurnal variation of declination the range of which (·00315) is also considerably less.

*By diurnal or annual variation *is always to be understood the series of* hourly or monthly values expressed by the excess of each above the mean value for the whole day or for the whole year respectively.

†In this and all the tables that follow, the positive sign indicates a movement of the north end of the horizontal force magnet to the northward of its normal direction and the deviations from the normal are expressed in *mm-mg-s* unit of force.

COLABA OBSERVATORY.

MEAN DIURNAL VARIATION OF THE HORIZONTAL FORCE FOR EACH MONTH AND FOR THE WHOLE YEAR.

Plate XXVII.

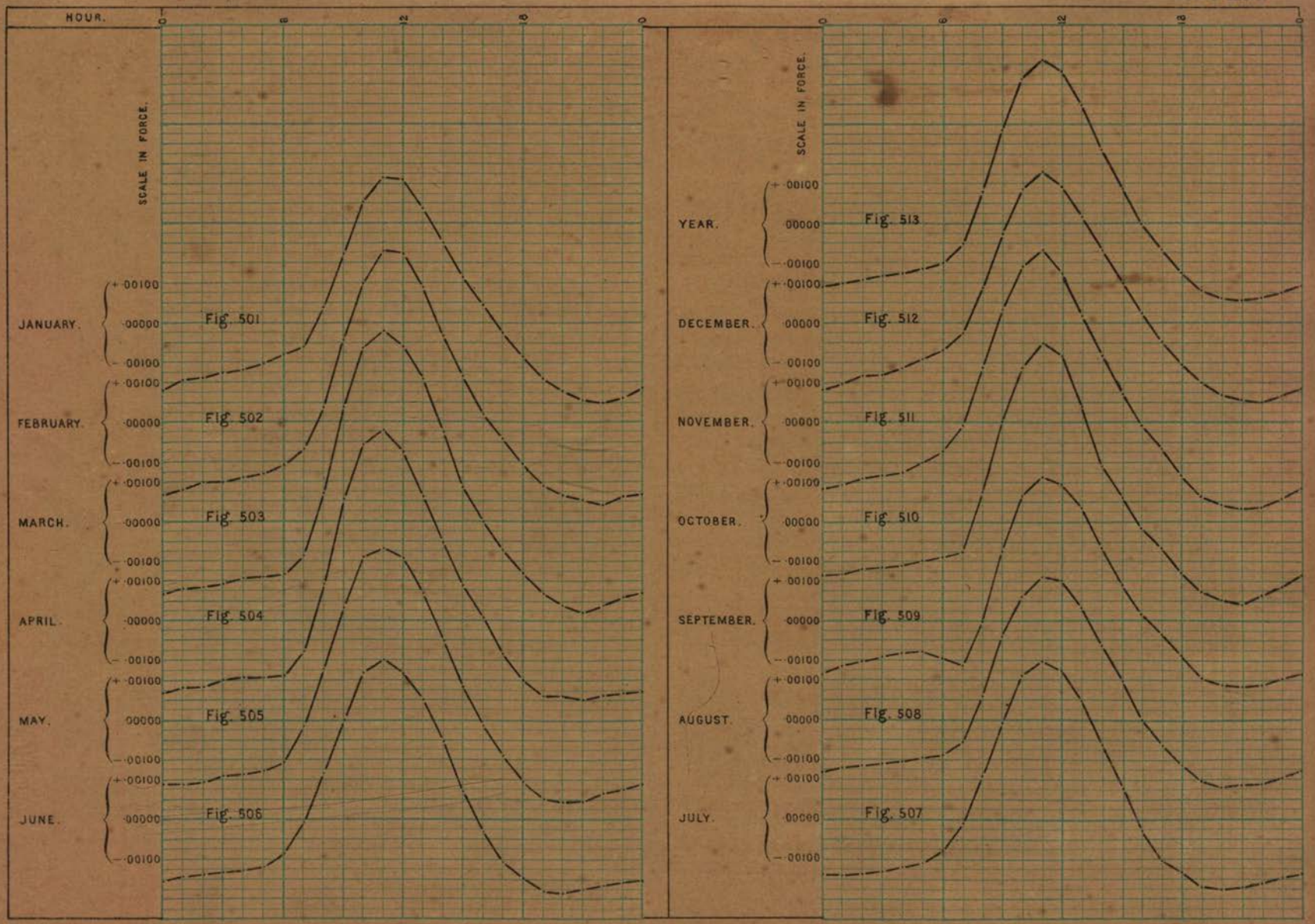


TABLE 101.—*Showing, for the half-years including the months from April to September in the several years* 1847 *to* 1872, *and in the whole period of twenty-six years, the mean diurnal variation of Horizontal Force.*

Bombay Civil Hours.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.													
0 14	−·00133	−·00180	−·00180	−·00130	−·00131	−·00094	−·00131	−·00088	−·00091	−·00125	−·00125	−·00158	−·00202
1 14	−·00144	−·00191	−·00169	−·00122	−·00123	−·00097	−·00113	−·00084	−·00088	−·00114	−·00113	−·00146	−·00196
2 14	−·00148	−·00180	−·00158	−·00112	−·00128	−·00083	−·00113	−·00073	−·00084	−·00097	−·00113	−·00141	−·00180
3 14	−·00148	−·00169	−·00151	−·00108	−·00098	−·00061	−·00099	−·00066	−·00080	−·00091	−·00096	−·00129	−·00168
4 14	−·00137	−·00169	−·00144	−·00104	−·00103	−·00068	−·00099	−·00055	−·00069	−·00080	−·00096	−·00124	−·00151
5 14	−·00140	−·00155	−·00126	−·00094	−·00096	−·00061	−·00088	−·00044	−·00069	−·00063	−·00090	−·00113	−·00151
6 14	−·00108	−·00126	−·00086	−·00097	−·00108	−·00068	−·00095	−·00073	−·00073	−·00057	−·00079	−·00096	−·00123
7 14	−·00043	−·00068	−·00032	−·00047	−·00063	−·00050	−·00058	−·00062	−·00036	−·00028	−·00045	−·00045	−·00084
8 14	+·00086	+·00079	+·00101	+·00072	+·00056	+·00061	+·00066	+·00033	+·00055	+·00085	+·00057	+·00107	+·00095
9 14	+·00248	+·00284	+·00263	+·00223	+·00205	+·00187	+·00215	+·00150	+·00182	+·00217	+·00198	+·00276	+·00331
10 14	+·00364	+·00407	+·00389	+·00328	+·00330	+·00299	+·00318	+·00274	+·00274	+·00313	+·00295	+·00394	+·00477
11 14	+·00371	+·00450	+·00436	+·00360	+·00383	+·00335	+·00350	+·00310	+·00292	+·00336	+·00329	+·00462	+·00505
12 14	+·00346	+·00414	+·00400	+·00331	+·00363	+·00306	+·00328	+·00277	+·00274	+·00319	+·00340	+·00417	+·00494
13 14	+·00284	+·00338	+·00313	+·00274	+·00299	+·00245	+·00281	+·00212	+·00223	+·00245	+·00289	+·00327	+·00381
14 14	+·00198	+·00227	+·00205	+·00169	+·00204	+·00155	+·00175	+·00135	+·00139	+·00148	+·00187	+·00203	+·00241
15 14	+·00094	+·00112	+·00094	+·00076	+·00079	+·00022	+·00073	+·00047	+·00051	+·00051	+·00085	+·00090	+·00107
16 14	+·00004	+·00025	−·00011	−·00022	−·00020	−·00061	−·00036	−·00029	−·00011	−·00034	+·00006	−·00023	−·00006
17 14	−·00079	−·00054	−·00083	−·00086	−·00087	−·00101	−·00106	−·00080	−·00073	−·00091	−·00062	−·00113	−·00084
18 14	−·00137	−·00115	−·00115	−·00144	−·00141	−·00140	−·00142	−·00120	−·00124	−·00125	−·00108	−·00158	−·00168
19 14	−·00162	−·00173	−·00162	−·00169	−·00186	−·00184	−·00172	−·00153	−·00161	−·00171	−·00164	−·00191	−·00224
20 14	−·00169	−·00180	−·00187	−·00166	−·00183	−·00180	−·00168	−·00153	−·00161	−·00177	−·00170	−·00214	−·00241
21 14	−·00158	−·00191	−·00194	−·00158	−·00166	−·00162	−·00150	−·00131	−·00146	−·00171	−·00170	−·00214	−·00230
22 14	−·00162	−·00191	−·00194	−·00148	−·00161	−·00130	−·00150	−·00120	−·00124	−·00154	−·00153	−·00203	−·00230
23 14	−·00148	−·00187	−·00184	−·00133	−·00148	−·00108	−·00124	−·00099	−·00109	−·00137	−·00130	−·00175	−·00213
Range ...	·00540	·00641	·00630	·00529	·00569	·00519	·00522	·00463	·00453	·00513	·00510	·00676	·00746

TABLE 101—*continued.*

Bombay Civil Hours.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	Twenty-six years, 1847 to 1872.
h. m.														
0 14 ...	−·00185	−·00190	−·00167	−·00150	−·00133	−·00111	−·00111	−·00100	−·00116	−·00176	−·00297	−·00242	−·00198	−·00151
1 14 ...	−·00185	−·00184	−·00162	−·00128	−·00123	−·00094	−·00105	−·00094	−·00116	−·00170	−·00236	−·00236	−·00214	−·00143
2 14 ...	−·00185	−·00179	−·00150	−·00117	−·00111	−·00100	−·00094	−·00105	−·00105	−·00159	−·00231	−·00220	−·00231	−·00137
3 14 ...	−·00174	−·00157	−·00145	−·00111	−·00100	−·00089	−·00083	−·00100	−·00105	−·00154	−·00236	−·00203	−·00220	−·00128
4 14 ...	−·00174	−·00151	−·00134	−·00106	−·00089	−·00066	−·00083	−·00088	−·00099	−·00148	−·00231	−·00198	−·00209	−·00121
5 14 ...	−·00157	−·00145	−·00128	−·00100	−·00100	−·00072	−·00066	−·00083	−·00094	−·00126	−·00220	−·00203	−·00203	−·00114
6 14 ...	−·00157	−·00129	−·00106	−·00078	−·00089	−·00061	−·00050	−·00072	−·00077	−·00104	−·00181	−·00176	−·00165	−·00100
7 14 ...	−·00090	−·00056	−·00061	−·00022	−·00022	−·00022	·00000	−·00017	−·00028	−·00027	−·00082	−·00066	−·00077	−·00047
8 14 ...	+·00107	+·00112	+·00072	+·00095	+·00100	+·00072	+·00094	+·00083	+·00066	+·00082	+·00121	+·00104	+·00077	+·00082
9 14 ...	+·00325	+·00313	+·00240	+·00239	+·00239	+·00199	+·00221	+·00199	+·00182	+·00236	+·00346	+·00308	+·00296	+·00243
10 14 ...	+·00477	+·00453	+·00379	+·00345	+·00311	+·00332	+·00304	+·00315	+·00287	+·00390	+·00522	+·00511	+·00489	+·00368
11 14 ...	+·00511	+·00498	+·00446	+·00378	+·00377	+·00343	+·00326	+·00332	+·00331	+·00429	+·00566	+·00544	+·00538	+·00405
12 14 ...	+·00466	+·00453	+·00395	+·00356	+·00316	+·00316	+·00293	+·00299	+·00315	+·00407	+·00572	+·00539	+·00494	+·00378
13 14 ...	+·00381	+·00352	+·00317	+·00289	+·00255	+·00211	+·00227	+·00216	+·00232	+·00335	+·00462	+·00440	+·00379	+·00299
14 14 ...	+·00258	+·00246	+·00206	+·00178	+·00139	+·00111	+·00144	+·00122	+·00132	+·00209	+·00324	+·00297	+·00247	+·00192
15 14 ...	+·00101	+·00101	+·00100	+·00072	+·00050	+·00028	+·00061	+·00050	+·00066	+·00099	+·00187	+·00165	+·00137	+·00084
16 14 ...	·00000	−·00028	+·00006	−·00028	−·00033	−·00039	−·00022	−·00028	+·00006	−·00005	+·00044	+·00027	+·00038	−·00010
17 14 ...	−·00090	−·00106	−·00084	−·00100	−·00111	−·00089	−·00088	−·00072	−·00055	−·00088	−·00038	−·00088	−·00049	−·00083
18 14 ...	−·00140	−·00157	−·00128	−·00145	−·00144	−·00138	−·00138	−·00116	−·00110	−·00121	−·00110	−·00165	−·00115	−·00133
19 14 ...	−·00219	−·00201	−·00167	−·00183	−·00178	−·00172	−·00177	−·00160	−·00149	−·00154	−·00198	−·00192	−·00159	−·00175
20 14 ...	−·00241	−·00224	−·00184	−·00183	−·00172	−·00166	−·00160	−·00160	−·00144	−·00187	−·00231	−·00220	−·00187	−·00184
21 14 ...	−·00236	−·00218	−·00201	−·00195	−·00161	−·00150	−·00171	−·00149	−·00155	−·00209	−·00258	−·00242	−·00198	−·00182
22 14 ...	−·00208	−·00201	−·00189	−·00178	−·00150	−·00133	−·00155	−·00133	−·00149	−·00192	−·00269	−·00242	−·00209	−·00173
23 14 ...	−·00190	−·00196	−·00178	−·00172	−·00128	−·00127	−·00122	−·00127	−·00132	−·00187	−·00275	−·00253	−·00220	−·00161
Range ...	·00752	·00722	·00647	·00573	·00555	·00515	·00503	·00492	·00486	·00638	·00869	·00797	·00769	·00589

Curves representing these variations are numbered 514 to 540 on Plate XXVIII.

COLABA OBSERVATORY.

MEAN DIURNAL VARIATION OF HORIZONTAL FORCE FOR THE HALF YEARS APRIL TO SEPTEMBER [——]
AND OCTOBER TO MARCH [– – –] IN EACH OF THE YEARS 1847 TO 1872 AND IN THE WHOLE PERIOD OF 26 YEARS.

Plate XXVIII.

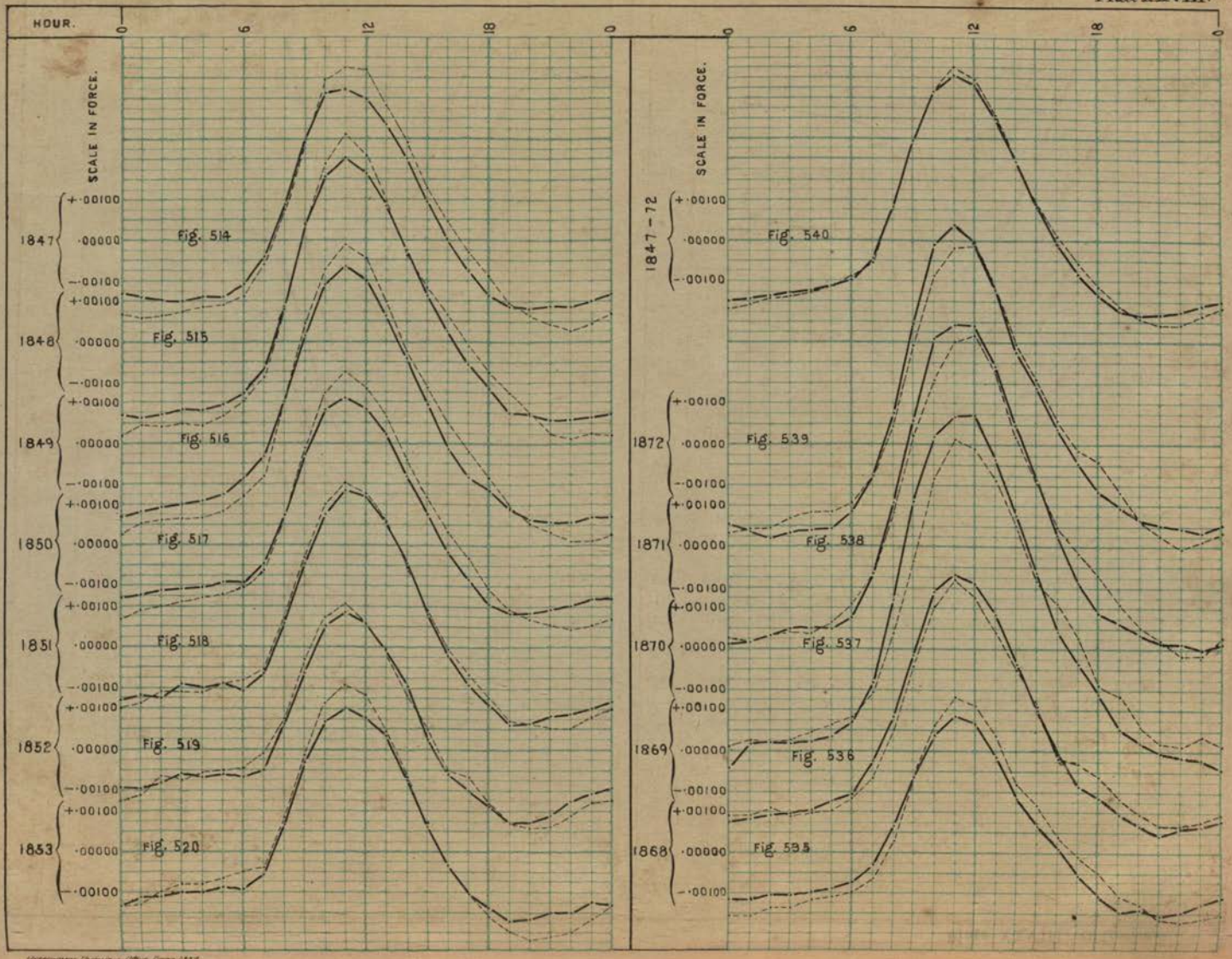
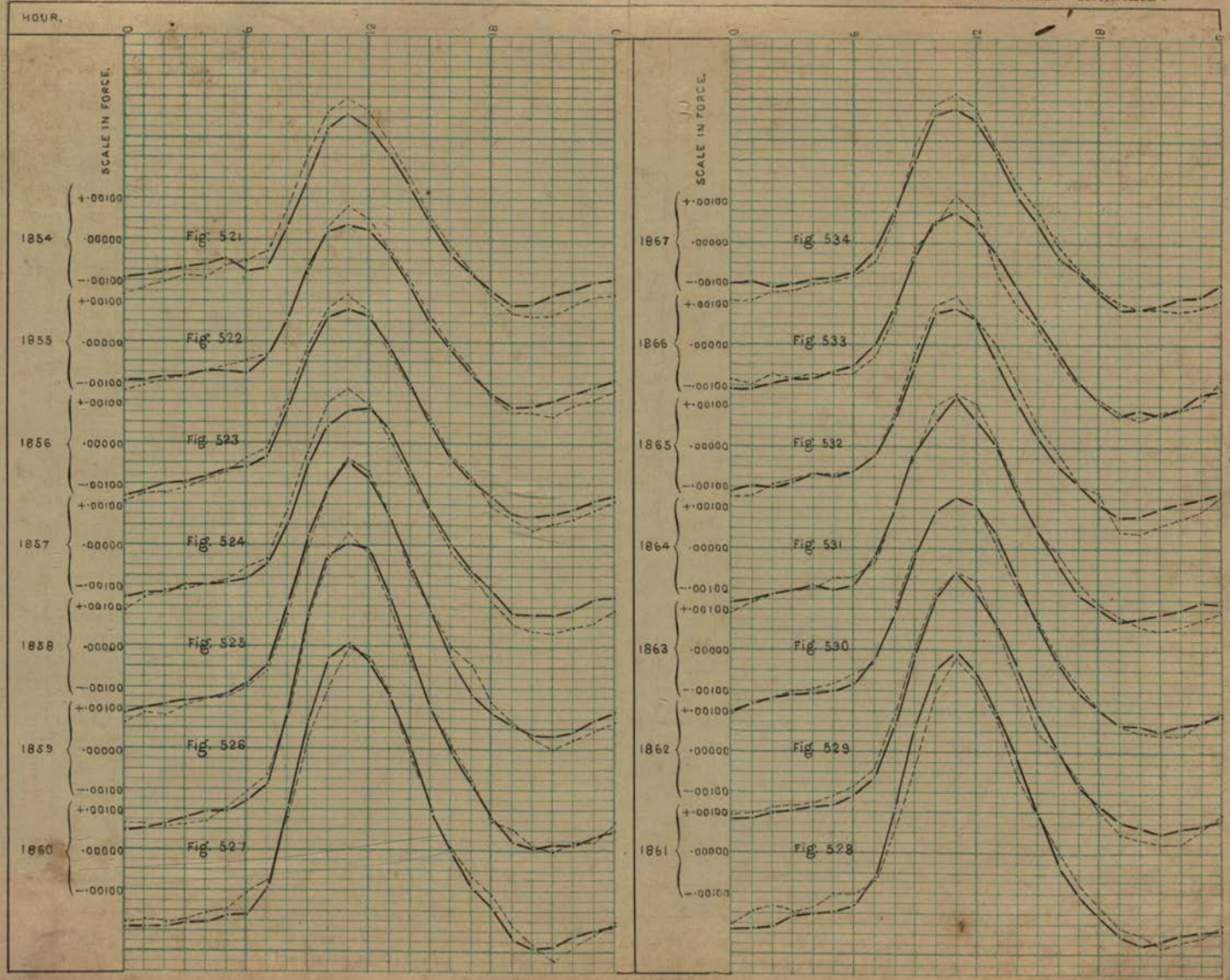


Plate XXVIII. *Continued.*



Government Photozinco Office Poona 1884.

TABLE 102.—*Showing, for the half-years including the months from January to March and October to December in the several years* 1847 *to* 1872, *and in the whole period of twenty-six years, the mean diurnal variation of Horizontal Force.*

Bombay Civil Hours.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.													
0 14... ...	−·00180	−·00230	−·00223	−·00184	−·00152	−·00126	−·00135	−·00128	−·00117	−·00137	−·00159	−·00180	−·00180
1 14... ...	−·00191	−·00205	−·00198	−·00162	−·00141	−·00112	−·00131	−·00113	−·00102	−·00120	−·00125	−·00158	−·00185
2 14... ...	−·00187	−·00212	−·00191	−·00151	−·00110	−·00068	−·00099	−·00099	−·00088	−·00120	−·00108	−·00163	−·00191
3 14... ...	−·00176	−·00202	−·00187	−·00140	−·00108	−·00076	−·00080	−·00084	−·00080	−·00108	−·00108	−·00141	−·00185
4 14... ...	−·00166	−·00205	−·00184	−·00130	−·00110	−·00061	−·00080	−·00088	−·00069	−·00085	−·00096	−·00124	−·00174
5 14... ...	−·00158	−·00184	−·00169	−·00122	−·00092	−·00050	−·00069	−·00058	−·00058	−·00068	−·00079	−·00118	−·00140
6 14... ...	−·00137	−·00148	−·00130	−·00108	−·00083	−·00047	−·00051	−·00047	−·00044	−·00034	−·00051	−·00090	−·00101
7 14... ...	−·00061	−·00090	−·00079	−·00061	−·00054	−·00011	−·00040	−·00026	−·00033	−·00011	−·00028	−·00056	−·00056
8 14... ...	+·00076	+·00083	+·00101	+·00072	+·00072	+·00076	+·00084	+·00077	+·00062	+·00108	+·00090	+·00079	+·00079
9 14... ...	+·00241	+·00288	+·00295	+·00241	+·00219	+·00220	+·00237	+·00208	+·00172	+·00245	+·00232	+·00248	+·00320
10 14... ...	+·00396	+·00439	+·00428	+·00374	+·00351	+·00320	+·00365	+·00318	+·00281	+·00336	+·00352	+·00394	+·00466
11 14... ...	+·00425	+·00508	+·00490	+·00425	+·00403	+·00356	+·00405	+·00350	+·00332	+·00370	+·00391	+·00467	+·00533
12 14... ...	+·00421	+·00454	+·00454	+·00385	+·00374	+·00306	+·00383	+·00321	+·00303	+·00331	+·00346	+·00434	+·00482
13 14... ...	+·00331	+·00346	+·00349	+·00313	+·00309	+·00248	+·00292	+·00245	+·00230	+·00228	+·00266	+·00327	+·00353
14 14... ...	+·00241	+·00212	+·00227	+·00205	+·00197	+·00133	+·00179	+·00157	+·00157	+·00137	+·00170	+·00191	+·00219
15 14... ...	+·00130	+·00133	+·00137	+·00119	+·00090	+·00047	+·00062	+·00062	+·00066	+·00063	+·00079	+·00090	+·00107
16 14... ...	+·00047	+·00068	+·00050	+·00032	−·00004	−·00050	−·00033	−·00011	−·00007	−·00028	−·00017	·00000	+·00011
17 14... ...	−·00029	−·00011	−·00022	−·00032	−·00064	−·00068	−·00109	−·00077	−·00062	−·00080	−·00074	−·00045	−·00073
18 14... ...	−·00090	−·00076	−·00086	−·00104	−·00125	−·00133	−·00161	−·00135	−·00131	−·00148	−·00136	−·00135	−·00174
19 14... ...	−·00155	−·00122	−·00158	−·00155	−·00182	−·00180	−·00201	−·00175	−·00172	−·00182	−·00193	−·00180	−·00196
20 14... ...	−·00184	−·00173	−·00194	−·00184	−·00190	−·00194	−·00223	−·00186	−·00172	−·00211	−·00204	−·00220	−·00236
21 14... ...	−·00205	−·00227	−·00220	−·00198	−·00202	−·00191	−·00212	−·00182	−·00179	−·00194	−·00215	−·00248	−·00252
22 14... ...	−·00223	−·00241	−·00241	−·00205	−·00199	−·00162	−·00201	−·00157	−·00157	−·00182	−·00198	−·00225	−·00224
23 14... ...	−·00205	−·00227	−·00241	−·00198	−·00172	−·00133	−·00168	−·00135	−·00139	−·00160	−·00187	−·00203	−·00224
Range	·00648	·00749	·00731	·00630	·00605	·00550	·00628	·00536	·00511	·00581	·00606	·00715	·00785

TABLE 102—*continued.*

Bombay Civil Hours.		1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	Twenty-six years, 1847 to 1872.
h.	m.														
0	14	−·00174	−·00173	−·00156	−·00156	−·00155	−·00122	−·00088	−·00138	−·00155	−·00159	−·00242	−·00225	−·00220	−·00165
1	14	−·00168	−·00145	−·00150	−·00128	−·00128	−·00116	−·00094	−·00138	−·00155	−·00159	−·00225	−·00236	−·00209	−·00154
2	14	−·00174	−·00129	−·00134	−·00117	−·00111	−·00089	−·00072	−·00116	−·00138	−·00143	−·00231	−·00220	−·00203	−·00141
3	14	−·00168	−·00145	−·00134	−·00100	−·00100	−·00078	−·00083	−·00116	−·00138	−·00159	−·00225	−·00209	−·00181	−·00135
4	14	−·00151	−·00134	−·00123	−·00089	−·00094	−·00066	−·00072	−·00100	−·00121	−·00154	−·00203	−·00214	−·00165	−·00126
5	14	−·00140	−·00101	−·00106	−·00078	−·00072	−·00066	−·00072	−·00088	−·00110	−·00148	−·00187	−·00187	−·00165	−·00111
6	14	−·00101	−·00101	−·00084	−·00061	−·00067	−·00061	−·00072	−·00077	−·00099	−·00115	−·00170	−·00143	−·00143	−·00092
7	14	−·00073	−·00067	−·00039	−·00028	−·00033	−·00022	−·00028	−·00044	−·00066	−·00071	−·00104	−·00066	−·00077	−·00052
8	14	+·00084	+·00067	+·00095	+·00111	+·00100	+·00083	+·00083	+·00072	+·00028	+·00049	+·00038	+·00082	+·00044	+·00077
9	14	+·00275	+·00218	+·00256	+·00245	+·00233	+·00233	+·00243	+·00243	+·00182	+·00203	+·00214	+·00269	+·00242	+·00240
10	14	+·00398	+·00402	+·00395	+·00345	+·00350	+·00349	+·00299	+·00343	+·00309	+·00352	+·00418	+·00407	+·00412	+·00369
11	14	+·00499	+·00481	+·00446	+·00378	+·00383	+·00377	+·00371	+·00371	+·00381	+·00418	+·00511	+·00500	+·00483	+·00425
12	14	+·00477	+·00430	+·00423	+·00361	+·00355	+·00316	+·00326	+·00332	+·00359	+·00374	+·00489	+·00517	+·00489	+·00394
13	14	+·00387	+·00341	+·00312	+·00261	+·00261	+·00249	+·00182	+·00238	+·00282	+·00291	+·00412	+·00429	+·00384	+·00303
14	14	+·00236	+·00196	+·00184	+·00161	+·00161	+·00161	+·00100	+·00149	+·00171	+·00198	+·00302	+·00269	+·00225	+·00190
15	14	+·00101	+·00101	+·00050	+·00078	+·00044	+·00061	+·00050	+·00083	+·00116	+·00104	+·00165	+·00154	+·00159	+·00093
16	14	+·00011	+·00006	+·00006	−·00017	−·00011	−·00011	−·00033	·00000	+·00039	−·00022	+·00110	+·00049	+·00060	+·00011
17	14	−·00067	−·00073	−·00072	−·00083	−·00078	−·00089	−·00094	−·00061	−·00011	−·00033	+·00027	−·00022	−·00016	−·00055
18	14	−·00107	−·00129	−·00139	−·00145	−·00133	−·00111	−·00133	−·00105	−·00050	−·00066	−·00088	−·00071	−·00044	−·00114
19	14	−·00185	−·00184	−·00201	−·00183	−·00166	−·00205	−·00166	−·00144	−·00110	−·00121	−·00121	−·00143	−·00121	−·00166
20	14	−·00230	−·00201	−·00212	−·00200	−·00189	−·00211	−·00182	−·00160	−·00132	−·00154	−·00192	−·00198	−·00187	−·00193
21	14	−·00269	−·00229	−·00223	−·00206	−·00200	−·00194	−·00166	−·00160	−·00166	−·00187	−·00236	−·00231	−·00225	−·00208
22	14	−·00236	−·00218	−·00223	−·00206	−·00189	−·00177	−·00160	−·00166	−·00177	−·00187	−·00242	−·00269	−·00258	−·00205
23	14	−·00202	−·00207	−·00189	−·00167	−·00172	−·00155	−·00144	−·00155	−·00171	−·00176	−·00220	−·00264	−·00242	−·00187
Range		·00768	·00710	·00669	·00584	·00583	·00588	·00553	·00537	·00558	·00605	·00753	·00786	·00747	·00633

Curves representing these variations (in broken lines) are numbered 514 to 540 on Plate XXVIII.

From the general likeness of the dotted and strong-line curves, neither of which is systematically of greater amplitude than the other, we see that there is in this case no semi-annual inequality corresponding to that which forms so striking a part of the declination variation: even in the average curves for all the years, it is seen to be very minute, the excess range being also in the half-year October to March, that is, contrary to what is found for the declination.

Table 103.

Showing the mean diurnal variation of Horizontal Force for each of the years 1847 *to* 1872.

Bombay Civil Hours.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
h. m.													
0 14	−·00156	−·00205	−·00201	−·00157	−·00142	−·00110	−·00133	−·00108	−·00104	−·00131	−·00142	−·00169	−·00191
1 14	−·00167	−·00198	−·00183	−·00142	−·00132	−·00104	−·00122	−·00098	−·00095	−·00117	−·00119	−·00152	−·00190
2 14	−·00167	−·00196	−·00174	−·00131	−·00119	−·00075	−·00106	−·00086	−·00086	−·00108	−·00110	−·00152	−·00185
3 14	−·00162	−·00185	−·00169	−·00124	−·00103	−·00068	−·00089	−·00075	−·00080	−·00099	−·00102	−·00135	−·00176
4 14	−·00151	−·00187	−·00164	−·00117	−·00106	−·00064	−·00089	−·00071	−·00069	−·00082	−·00096	−·00124	−·00162
5 14	−·00149	−·00169	−·00147	−·00108	−·00094	−·00055	−·00078	−·00051	−·00063	−·00065	−·00084	−·00115	−·00145
6 14	−·00122	−·00137	−·00108	−·00102	−·00095	−·00057	−·00073	−·00060	−·00058	−·00045	−·00065	−·00093	−·00112
7 14	−·00052	−·00079	−·00055	−·00054	−·00087	−·00030	−·00049	−·00044	−·00034	−·00019	−·00036	−·00050	−·00070
8 14	+·00081	+·00081	+·00101	+·00072	+·00064	+·00068	+·00075	+·00055	+·00058	+·00096	+·00073	+·00093	+·00087
9 14	+·00244	+·00286	+·00279	+·00232	+·00212	+·00203	+·00226	+·00179	+·00177	+·00231	+·00215	+·00262	+·00325
10 14	+·00380	+·00423	+·00408	+·00351	+·00340	+·00309	+·00341	+·00296	+·00277	+·00324	+·00323	+·00394	+·00471
11 14	+·00398	+·00479	+·00463	+·00392	+·00392	+·00345	+·00377	+·00330	+·00312	+·00353	+·00360	+·00464	+·00519
12 14	+·00383	+·00434	+·00427	+·00358	+·00368	+·00306	+·00355	+·00299	+·00288	+·00325	+·00343	+·00425	+·00488
13 14	+·00307	+·00342	+·00331	+·00293	+·00303	+·00246	+·00286	+·00228	+·00226	+·00236	+·00277	+·00327	+·00367
14 14	+·00219	+·00219	+·00216	+·00187	+·00200	+·00144	+·00177	+·00146	+·00148	+·00142	+·00178	+·00197	+·00230
15 14	+·00112	+·00122	+·00115	+·00097	+·00084	+·00034	+·00067	+·00054	+·00058	+·00057	+·00082	+·00090	+·00107
16 14	+·00025	+·00046	+·00019	+·00005	−·00011	−·00055	−·00034	−·00020	−·00009	−·00031	−·00005	−·00011	+·00002
17 14	−·00054	−·00032	−·00052	−·00059	−·00075	−·00084	−·00107	−·00078	−·00067	−·00085	−·00068	−·00079	−·00078
18 14	−·00113	−·00095	−·00100	−·00124	−·00132	−·00136	−·00151	−·00127	−·00127	−·00136	−·00122	−·00146	−·00171
19 14	−·00158	−·00147	−·00160	−·00162	−·00183	−·00182	−·00186	−·00164	−·00166	−·00176	−·00178	−·00185	−·00210
20 14	−·00176	−·00176	−·00190	−·00175	−·00186	−·00187	−·00195	−·00169	−·00166	−·00194	−·00187	−·00217	−·00238
21 14	−·00181	−·00209	−·00207	−·00178	−·00183	−·00176	−·00181	−·00156	−·00162	−·00182	−·00192	−·00231	−·00241
22 14	−·00192	−·00216	−·00217	−·00176	−·00180	−·00146	−·00175	−·00138	−·00140	−·00168	−·00175	−·00214	−·00227
23 14	−·00176	−·00207	−·00212	−·00165	−·00159	−·00120	−·00146	−·00117	−·00124	−·00148	−·00158	−·00189	−·00218
Range	·00599	·00695	·00680	·00570	·00578	·00532	·00572	·00499	·00478	·00547	·00552	·00695	·00760

825—44 AT

TABLE 103—*continued.*

Bombay Civil Hours.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
h. m.													
0 14	−·00179	−·00181	−·00161	−·00153	−·00144	−·00116	−·00099	−·00119	−·00135	−·00167	−·00269	−·00233	−·00209
1 14	−·00176	−·00164	−·00156	−·00128	−·00125	−·00105	−·00099	−·00116	−·00135	−·00164	−·00230	−·00236	−·00211
2 14	−·00179	−·00154	−·00142	−·00117	−·00111	−·00094	−·00083	−·00110	−·00121	−·00151	−·00231	−·00220	−·00217
3 14	−·00171	−·00151	−·00139	−·00105	−·00100	−·00083	−·00083	−·00108	−·00121	−·00156	−·00230	−·00206	−·00200
4 14	−·00162	−·00142	−·00128	−·00097	−·00091	−·00066	−·00077	−·00094	−·00110	−·00151	−·00217	−·00206	−·00187
5 14	−·00148	−·00123	−·00117	−·00089	−·00086	−·00069	−·00069	−·00085	−·00102	−·00137	−·00203	−·00195	−·00184
6 14	−·00129	−·00115	−·00095	−·00069	−·00078	−·00061	−·00061	−·00074	−·00088	−·00109	−·00175	−·00159	−·00154
7 14	−·00081	−·00061	−·00050	−·00025	−·00027	−·00022	−·00014	−·00030	−·00047	−·00049	−·00093	−·00066	−·00077
8 14	+·00095	+·00089	+·00083	+·00103	+·00100	+·00077	+·00088	+·00077	+·00047	+·00065	+·00079	+·00093	+·00060
9 14	+·00300	+·00265	+·00248	+·00242	+·00236	+·00216	+·00232	+·00221	+·00182	+·00219	+·00280	+·00288	+·00269
10 14	+·00437	+·00427	+·00387	+·00345	+·00330	+·00340	+·00301	+·00329	+·00298	+·00371	+·00470	+·00459	+·00450
11 14	+·00505	+·00489	+·00446	+·00378	+·00380	+·00360	+·00348	+·00351	+·00356	+·00423	+·00538	+·00522	+·00510
12 14	+·00471	+·00441	+·00409	+·00358	+·00335	+·00316	+·00309	+·00315	+·00337	+·00390	+·00530	+·00528	+·00491
13 14	+·00384	+·00346	+·00314	+·00275	+·00258	+·00230	+·00204	+·00227	+·00257	+·00313	+·00437	+·00434	+·00381
14 14	+·00247	+·00221	+·00195	+·00169	+·00150	+·00136	+·00122	+·00135	+·00151	+·00203	+·00313	+·00283	+·00236
15 14	+·00101	+·00101	+·00075	+·00075	+·00047	+·00044	+·00055	+·00066	+·00091	+·00101	+·00176	+·00159	+·00148
16 14	+·00005	−·00011	+·00006	−·00022	−·00022	−·00025	−·00027	−·00014	+·00022	−·00013	+·00077	+·00038	+·00049
17 14	−·00078	−·00089	−·00078	−·00091	−·00094	−·00089	−·00091	−·00066	−·00033	−·00060	−·00005	−·00055	−·00032
18 14	−·00123	−·00143	−·00133	−·00145	−·00138	−·00124	−·00135	−·00110	−·00080	−·00093	−·00099	−·00118	−·00079
19 14	−·00202	−·00192	−·00184	−·00183	−·00172	−·00188	−·00171	−·00152	−·00129	−·00137	−·00159	−·00167	−·00140
20 14	−·00235	−·00212	−·00198	−·00191	−·00180	−·00188	−·00171	−·00160	−·00138	−·00170	−·00211	−·00209	−·00187
21 14	−·00252	−·00223	−·00212	−·00200	−·00180	−·00172	−·00168	−·00154	−·00160	−·00198	−·00247	−·00236	−·00211
22 14	−·00222	−·00209	−·00206	−·00192	−·00169	−·00155	−·00157	−·00149	−·00163	−·00189	−·00255	−·00255	−·00233
23 14	−·00199	−·00201	−·00183	−·00169	−·00150	−·00141	−·00133	−·00141	−·00151	−·00181	−·00247	−·00258	−·00231
Range	·00757	·00712	·00658	·00578	·00560	·00548	·00519	·00511	·00519	·00621	·00807	·00786	·00743

232. The coefficients of the series (y) [see paragraph 148], expressing the equivalent north magnetic force to the deviation of the horizontal force magnet from its normal position at each hour, have been calculated for each month of the typical year and for each of the years 1847 to 1872, with the results shown in Tables 104 and 105,

Table 104.

Showing the calculated values of the coefficients A_1, B_1; A_2, B_2; A_3, B_3; A_4 and B_4 in the series (y) which expresses the mean solar-diurnal variation for each month of the year and for the whole year.

Months.	Values of the coefficients of the first four pairs of terms of the series (y).							
	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
January ...	− ·00241	+ ·00022	+ ·00092	+ ·00003	− ·00025	+ ·00027	+ ·00006	− ·00015
February ...	− ·00268	+ ·00023	+ ·00115	− ·00008	− ·00034	+ ·00030	+ ·00008	− ·00016
March ...	− ·00290	+ ·00041	+ ·00135	− ·00027	− ·00032	+ ·00045	·00000	− ·00022
April ...	− ·00280	+ ·00045	+ ·00133	− ·00038	− ·00027	+ ·00045	− ·00012	− ·00027
May ...	− ·00271	+ ·00059	+ ·00124	− ·00035	− ·00018	+ ·00030	− ·00005	− ·00015
June ...	− ·00245	+ ·00058	+ ·00118	− ·00033	− ·00021	+ ·00022	− ·00005	− ·00007
July ...	− ·00240	+ ·00054	+ ·00115	− ·00032	− ·00023	+ ·00021	− ·00001	− ·00009
August ...	− ·00230	+ ·00036	+ ·00108	− ·00009	− ·00024	+ ·00024	·00000	− ·00015
September ...	− ·00213	+ ·00023	+ ·00107	+ ·00005	− ·00036	+ ·00033	+ ·00001	− ·00026
October ...	− ·00247	+ ·00056	+ ·00124	− ·00023	− ·00032	+ ·00046	+ ·00008	− ·00027
November ...	− ·00262	+ ·00069	+ ·00103	− ·00029	− ·00014	+ ·00041	− ·00001	− ·00017
December ...	− ·00243	+ ·00043	+ ·00090	− ·00013	− ·00019	+ ·00031	·00000	− ·00015
Year	− ·00252	+ ·00044	+ ·00114	− ·00020	− ·00025	+ ·00033	·00000	− ·00018

Table 105.

Showing the calculated values of the coefficients A_1, B_1; A_2, B_2; A_3, B_3; A_4 and B_4 in the series (y), which expresses the mean solar-diurnal variation for each of the years 1847 *to* 1872.

Years.	Values of the coefficients of the first four pairs of terms of the series (y).							
	A_1	B_1	A_2	B_2	A_3	B_3	A_4	B_4
1847	− ·00262	+ ·00025	+ ·00088	− ·00011	− ·00017	+ ·00031	− ·00004	− ·00014
1848	− ·00303	+ ·00015	+ ·00119	− ·00032	− ·00025	+ ·00046	− ·00002	− ·00021
1849	− ·00291	+ ·00031	+ ·00114	− ·00022	− ·00025	+ ·00041	− ·00016	− ·00041
1850	− ·00240	+ ·00037	+ ·00109	− ·00017	− ·00024	+ ·00031	− ·00005	− ·00017
1851	− ·00235	+ ·00045	+ ·00117	− ·00009	− ·00029	+ ·00026	− ·00001	− ·00014
1852	− ·00191	+ ·00065	+ ·00104	− ·00012	− ·00025	+ ·00025	+ ·00002	− ·00018
1853	− ·00222	+ ·00062	+ ·00116	− ·00014	− ·00029	+ ·00025	− ·00003	− ·00015
1854	− ·00185	+ ·00053	+ ·00098	− ·00009	− ·00023	+ ·00022	·00000	− ·00020
1855	− ·00184	+ ·00051	+ ·00094	− ·00005	− ·00018	+ ·00020	·00000	− ·00017
1856	− ·00211	+ ·00066	+ ·00096	− ·00020	− ·00018	+ ·00026	+ ·00001	− ·00017
1857	− ·00223	+ ·00051	+ ·00103	− ·00008	− ·00021	+ ·00026	·00000	− ·00015
1858	− ·00273	+ ·00056	+ ·00125	− ·00019	− ·00028	+ ·00037	+ ·00004	− ·00019
1859	− ·00316	+ ·00054	+ ·00143	− ·00031	− ·00030	+ ·00042	·00000	− ·00026
1860	− ·00308	+ ·00044	+ ·00143	− ·00023	− ·00027	+ ·00042	+ ·00006	− ·00020
1861	− ·00287	+ ·00051	+ ·00134	− ·00024	− ·00033	+ ·00039	+ ·00001	− ·00020
1862	− ·00265	+ ·00050	+ ·00121	− ·00021	− ·00028	+ ·00037	+ ·00003	− ·00018
1863	− ·00234	+ ·00064	+ ·00106	− ·00017	− ·00022	+ ·00028	− ·00003	− ·00011
1864	− ·00218	+ ·00062	+ ·00103	− ·00023	− ·00023	+ ·00030	− ·00003	− ·00014
1865	− ·00203	+ ·00066	+ ·00101	− ·00017	− ·00021	+ ·00031	− ·00001	− ·00023
1866	− ·00193	+ ·00065	+ ·00097	− ·00021	− ·00015	+ ·00030	− ·00002	− ·00017
1867	− ·00204	+ ·00047	+ ·00095	− ·00025	− ·00018	+ ·00031	− ·00002	− ·00019
1868	− ·00213	+ ·00022	+ ·00091	− ·00013	− ·00024	+ ·00029	+ ·00005	− ·00016
1869	− ·00260	+ ·00026	+ ·00112	− ·00022	− ·00027	+ ·00035	+ ·00004	− ·00013
1870	− ·00360	·00000	+ ·00137	− ·00019	− ·00032	+ ·00043	+ ·00001	− ·00018
1871	− ·00349	+ ·00018	+ ·00139	− ·00021	− ·00036	+ ·00039	+ ·00001	− ·00010
1872	− ·00321	+ ·00009	+ ·00127	− ·00029	− ·00034	+ ·00047	+ ·00005	− ·00022

233. With respect to the effect of progressive change of horizontal force on these coefficients, the remarks made in paragraph 149 apply also in this case: the greatest change of scale reading in a year is 2·07 which is at the rate of about ·006 *per* day, or ·00002 expressed in force; hence the greatest effect on the coefficients will be less than unity in the fifth place of decimals and may be disregarded. That part of the progressive change which is due to annual variation of the horizontal force may, it will be seen from paragraphs 235 to 240, also be neglected. Even for the month of January 1851, when the untwisting of the wire caused a change of scale-reading at the rate of about ·03 per day, the greatest effect on any of the coefficients is only about ·00003, and before the end of the following month this had been reduced to ·00001.

234. *Variation from year to year in the range of the mean diurnal variation of Horizontal Force.*—These ranges for the summer and winter half-years and for the full years are shown at the feet of Tables 101 to 103 and their changes from year to year are graphically displayed in Figs. 259 to 261 (Plate XVI). As in the corresponding declination results, so here the sun-spot period is strongly marked: the maxima occur in 1848-49, 1859-60 and 1870-71 and the minima in 1855 and 1866-68; and the maxima and minima, taken in order, are of the magnitudes ·00687; ·00478; ·00758; ·00516 and ·00796: the average maximum range is here, as in the case of the declination, about half as great again as the average minimum.

235. *Annual variation.*—In paragraphs 197 to 205 and 211 a method was described of finding the secular variation of horizontal force from mean monthly scale-readings of Grubb's magnetometer, inclusive of disturbances. For the present purpose that method has been applied also to the monthly means of the final normals—after the exclusion of disturbances exceeding ·00334 in amount. In this case the periods of approximately uniform rate of change of scale-reading are taken as 1847·0 to 1851·0, 1851·5 to 1853·0, 1853·0 to 1856·0, 1860·0 to 1866·0, and 1866·5 to 1873·0, and the corresponding rates of increase are +1·97, +1·95, +1·34, +0·56 and +0·44 for the epochs 1849·0, 1852·25, 1854·5, 1863·0 and 1869·97 respectively, and the last is still 0·44 when corrected to the epoch 1870·0. Allowing for the values of the scale-coefficient at the different epochs, indicated in Table 82 (paragraph 203), and assuming—as before—that the growth (or rather decay) of the rate of increase between the epochs is at a uniform rate, the secular changes from the several epochs to each month of the periods to which they correspond are calculated and found to be as follows:—

TABLE 106.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1847 ...	−3·87	−3·70	−3·54	−3·37	−3·21	−3·04	−2·88	−2·71	−2·55	−2·38	−2·22	−2·05
1848 ...	−1·89	−1·73	−1·56	−1·40	−1·23	−1·07	−0·90	−0·74	−0·57	−0·41	−0·25	−0·08
1849 ...	+0·08	+0·25	+0·41	+0·57	+0·74	+0·90	+1·07	+1·23	+1·39	+1·56	+1·72	+1·89
1850 ...	+2·05	+2·21	+2·38	+2·54	+2·70	+2·87	+3·03	+3·19	+3·36	+3·52	+3·68	+3·85
1852 ...	−0·41	−0·24	−0·08	+0·08	+0·24	+0·40	+0·56	+0·71	+0·87	+1·02	+1·17	+1·32
1853 ...	−2·23	−2·09	−1·95	−1·81	−1·67	−1·54	−1·40	−1·27	−1·14	−1·02	−0·89	−0·76
1854 ...	−0·64	−0·52	−0·40	−0·29	−0·17	−0·06	+0·06	+0·17	+0·28	+0·39	+0·50	+0·61
1855 ...	+0·72	+0·83	+0·94	+1·04	+1·15	+1·26	+1·37	+1·47	+1·58	+1·68	+1·79	+1·89
1860 ...	−1·82	−1·77	−1·71	−1·66	−1·60	−1·55	−1·49	−1·44	−1·38	−1·33	−1·28	−1·22
1861 ...	−1·17	−1·12	−1·06	−1·01	−0·96	−0·91	−0·86	−0·81	+0·76	−0·70	−0·65	−0·60
1862 ...	−0·55	−0·50	−0·46	−0·41	−0·36	−0·31	−0·26	−0·21	−0·17	−0·12	−0·07	−0·02
1863 ...	+0·02	+0·07	+0·12	+0·16	+0·21	+0·25	+0·30	+0·35	+0·39	+0·44	+0·48	+0·53
1864 ...	+0·57	+0·62	+0·66	+0·71	+0·75	+0·80	+0·84	+0·89	+0·93	+0·98	+1·02	+1·06
1865 ...	+1·11	+1·15	+1·19	+1·24	+1·28	+1·32	+1·37	+1·41	+1·45	+1·49	+1·54	+1·58
1867 ...	−1·38	−1·34	−1·30	−1·26	−1·22	−1·18	−1·14	−1·10	−1·06	−1·02	−0·98	−0·94
1868 ...	−0·90	−0·86	−0·82	−0·78	−0·74	−0·70	−0·66	−0·62	−0·58	−0·55	−0·51	−0·47
1869 ...	+0·43	−0·39	−0·35	−0·32	−0·28	−0·24	−0·20	−0·17	−0·13	−0·09	−0·06	−0·02
1870 ...	+0·02	+0·05	+0·09	+0·13	+0·16	+0·20	+0·24	+0·27	+0·31	+0·34	+0·38	+0·41
1871 ...	+0·45	+0·48	+0·52	+0·55	+0·59	+0·62	+0·66	+0·69	+0·73	+0·76	+0·79	+0·83
1872 ...	+0·86	+0·89	+0·94	+0·97	+1·00	+1·04	+1·07	+1·10	+1·14	+1·17	+1·20	+1·23

The monthly means of the final normals are shown in Table 107 :—

TABLE 107.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Annual increment.
1847 ...	18·16	17·84	17·96	18·14	18·44	18·61	18·64	18·87	19·01	18·90	18·99	19·30	18·57	
1848 ...	19·26	19·81	20·14	20·35	20·60	20·90	20·78	20·93	21·91	21·00	21·02	21·03	20·64	+2·07
1849 ...	21·43	21·82	22·18	22·44	22·62	22·51	22·59	22·77	22·80	22·90	23·09	23·46	22·55	+1·91
1850 ...	23·66	23·93	24·25	24·40	24·53	24·55	24·41	24·61	24·61	24·69	25·00	25·06	24·48	+1·93
1851 ...	21·29	21·41	21·67	21·81	21·69	22·03	22·12	22·22	22·00	22·38	22·97	22 91	22·04	...
1852 ...	23·24	23·04	23·41	23·57	23·97	24·17	24·18	24·34	24·17	24·38	24·60	24·65	23·98	...
1853 ...	12·85	13·05	13·29	13·58	13·55	13·54	13·56	13·82	13·60	14·10	14·16	14 23	13·61	...
1854 ...	14·46	14·59	14·75	14·56	14·85	15·11	14·80	14·98	14·92	15·22	15·47	15·61	14·94	+1·33
1855 ...	15·96	15·94	16·15	16·22	16·26	16·33	16·09	16·20	16·33	16·40	16·63	16·96	16·29	+1·35
1856 ...	17·99	19·20	19·06	19·09	19·20	18·89	18·79	18·70	18·67	18·73	19 05	19·16	18·88	...
1857 ...	19·21	19·38	19·35	19·35	19·21	19·27	18·96	18·86	18·58	18·69	18·63	18·91	19·03	...
1858 ...	18·80	18·84	18·71	18·78	18·86	18·75	18·48	18·51	18·48	18·43	18·96	18·92	18·71	...
1859 ...	19·15	19·24	19·12	19·25	19·26	19·13	19·28	19·56	19·08	19·16	19·38	19·44	19·25	...
1860 ...	19·64	20·05	19·71	19·33	19·52	19·57	19·61	19·42	19·43	19·85	20·23	20·28	19·72	...
1861 ...	20·43	20·41	20·44	20·52	20·58	20·00	20·29	20·17	20·13	20·30	20·39	20·50	20·35	+0·63
1862 ...	20·75	20·93	21·01	20·94	20·91	20·99	20·61	20·38	20·48	20·37	20·76	21·04	20·76	+0·41
1863 ...	21·15	21·22	21·42	21·34	21·53	21·31	21·18	20·97	20·97	21·18	21·45	21·43	21·26	+0·50
1864 ...	21·83	21·92	21·89	21·75	21·63	21·61	21·49	21·46	21·46	21 91	22 24	22·38	21·80	+0·54
1865 ...	22·41	22·60	22·77	22·79	22·76	22·61	22·48	21·84	22·16	22·11	22·48	22·96	22·50	+0·70
1866 ...	22·98	23·06	22·95	23·19	23·34	23·43	...	...	...	...	...	...	...	...
1866 ...	...	...	...	...	...	22·82	22·63	22·44	22·44	22·51	23·05	23·45	...	...
1867 ...	23·67	23·83	23·58	23·64	23·66	23·57	23·42	23·25	23·11	23·15	23·80	24·02	23·56	...
1868 ...	24·17	24·09	24·25	23·95	24·06	24·00	23·87	23·80	23·54	23·72	24·27	24·27	24·00	+0·44
1869 ...	24·10	24·14	24·15	23·94	24·12	24·16	24·16	23·93	23·68	23·93	24·36	24·45	24·09	+0·09
1870 ...	24·35	24·36	24·50	24·46	24·88	24·79	24·81	24·51	24·18	24·17	24·39	24·88	24·52	+0·43
1871 ...	24·85	25·06	24·90	24·53	25·11	25·12	24·90	24·74	24·77	24·82	24·72	25·18	24·89	+0·37
1872 ...	25·40	25·39	25·17	25·54	25·67	25·41	25·26	25·08	24·99	25·09	25·12	25·06	25·26	+0·37

236. On account of changing torsion in the wires of the horizontal force magnetometer no use was made, for the present purpose, of the observations of the years 1851 and 1856 to 1859, nor, on account of the breakage of the reading wire of the telescope, was any use made of the observations of the year 1866. For the remaining years the numbers in Table 106 were subtracted from the corresponding numbers in Table 107, the differences being then regarded as affected simply by the annual variation of horizontal force. The variation was taken for each year, and converted into force with the results shown in Table 108, where average variations are taken for the periods 1847 to 1850, 1852 to 1855, 1860 to 1865, and 1867 to 1872 and for these periods combined. Curves representing the annual variation for these periods are constructed in Figs. 541 to 545.

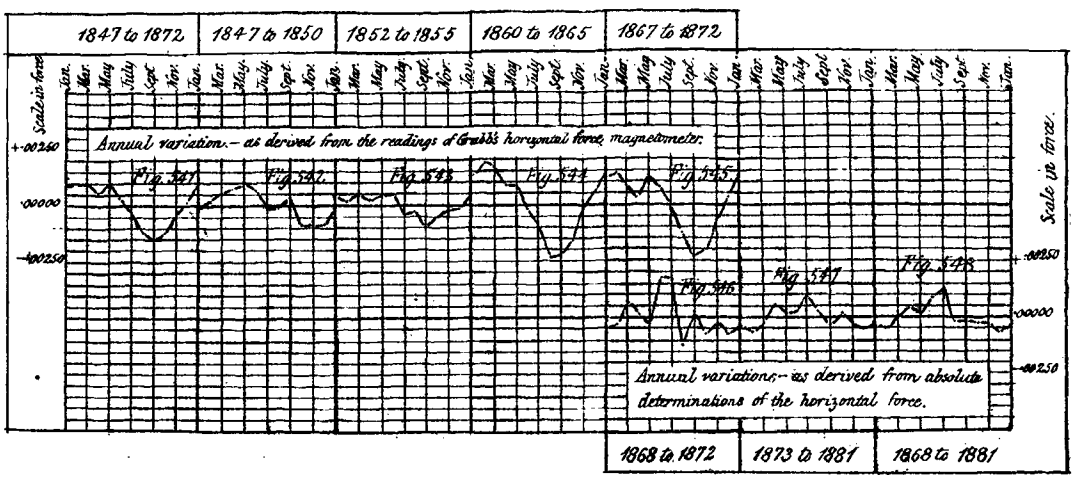
Table 108.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1847	+ ·00180	+ ·00004	− ·00011	− ·00007	+ ·00043	+ ·00043	− ·00004	+ ·00018	+ ·00011	− ·00090	− ·00115	− ·00065
1848	− ·00173	− ·00032	+ ·00025	+ ·00043	+ ·00072	+ ·00122	+ ·00018	+ ·00014	+ ·00306	− ·00079	− ·00130	− ·00187
1849	− ·00079	·00000	+ ·00072	+ ·00108	+ ·00112	+ ·00014	+ ·00018	− ·00011	− ·00058	− ·00083	− ·00072	·00000
1850	+ ·00029	+ ·00068	+ ·00122	+ ·00119	+ ·00108	+ ·00054	− ·00054	− ·00040	− ·00101	− ·00130	− ·00076	− ·00115
1852	+ ·00050	− ·00083	− ·00007	− ·00007	+ ·00079	+ ·00094	+ ·00040	+ ·00043	− ·00076	− ·00054	− ·00029	− ·00065
1853	− ·00007	+ ·00051	+ ·00051	+ ·00106	+ ·00044	− ·00007	− ·00051	− ·00004	− ·00131	+ ·00007	− ·00018	− ·00040
1854	+ ·00056	+ ·00058	+ ·00073	− ·00036	+ ·00026	+ ·00080	− ·00077	− ·00051	− ·00113	− ·00044	+ ·00007	+ ·00018
1855	+ ·00095	+ ·00047	+ ·00084	+ ·00073	+ ·00047	+ ·00033	− ·00095	− ·00091	− ·00084	− ·00095	− ·00051	+ ·00033
1860	+ ·00123	+ ·00325	+ ·00101	− ·00140	− ·00067	− ·00067	− ·00079	− ·00213	− ·00241	− ·00034	+ ·00151	+ ·00146
1861	+ ·00207	+ ·00168	+ ·00151	+ ·00168	+ ·00173	− ·00179	− ·00045	− ·00140	− ·00190	− ·00129	− ·00106	− ·00073
1862	+ ·00139	+ ·00212	+ ·00234	+ ·00167	+ ·00123	+ ·00139	− ·00100	− ·00256	− ·00223	− ·00312	− ·00123	+ ·00006
1863	+ ·00078	+ ·00089	+ ·00172	+ ·00106	+ ·00183	+ ·00039	− ·00061	− ·00206	− ·00228	− ·00139	− ·00011	− ·00050
1864	+ ·00155	+ ·00178	+ ·00139	+ ·00033	− ·00055	− ·00094	− ·00183	− ·00228	− ·00250	− ·00028	+ ·00133	+ ·00189
1865	+ ·00083	+ ·00166	+ ·00238	+ ·00222	+ ·00183	+ ·00078	− ·00022	− ·00399	− ·00244	− ·00294	− ·00116	+ ·00127
1867	+ ·00182	+ ·00249	+ ·00088	+ ·00100	+ ·00088	+ ·00017	− ·00088	− ·00205	− ·00304	− ·00304	+ ·00033	+ ·00133
1868	+ ·00215	+ ·00149	+ ·00215	+ ·00028	+ ·00066	+ ·00011	− ·00083	− ·00144	− ·00309	− ·00226	+ ·00055	+ ·00033
1869	+ ·00115	+ ·00115	+ ·00099	− ·00033	+ ·00044	+ ·00044	+ ·00022	− ·00121	− ·00280	− ·00165	+ ·00055	+ ·00082
1870	+ ·00011	·00000	+ ·00055	+ ·00011	+ ·00225	+ ·00154	+ ·00143	− ·00038	− ·00242	− ·00264	− ·00165	+ ·00088
1871	+ ·00082	+ ·00181	+ ·00071	− ·00148	+ ·00148	+ ·00137	− ·00005	− ·00110	− ·00115	− ·00104	− ·00176	+ ·00055
1872	+ ·00181	+ ·00159	+ ·00011	+ ·00198	+ ·00253	+ ·00088	− ·00011	− ·00126	− ·00198	− ·00159	− ·00159	− ·00209
1847 to 1850 ...	− ·00011	+ ·00010	+ ·00052	+ ·00066	+ ·00084	+ ·00058	− ·00005	− ·00005	+ ·00039	− ·00095	− ·00098	− ·00092
1852 to 1855 ...	+ ·00048	+ ·00018	+ ·00050	+ ·00034	+ ·00049	+ ·00050	− ·00046	− ·00026	− ·00101	− ·00046	− ·00023	− ·00013
1860 to 1865 ...	+ ·00131	+ ·00190	+ ·00172	+ ·00093	+ ·00090	− ·00014	− ·00082	− ·00240	− ·00229	− ·00156	− ·00012	+ ·00057
1867 to 1872 ...	+ ·00131	+ ·00142	+ ·00090	+ ·00026	+ ·00137	+ ·00075	− ·00004	− ·00124	− ·00241	− ·00204	− ·00059	+ ·00030
1847 to 1872 ...	+ ·00086	+ ·00105	+ ·00099	+ ·00056	+ ·00095	+ ·00040	− ·00036	− ·00115	− ·00153	− ·00136	− ·00046	+ ·00005

237. The corresponding results to those of Table 108, when disturbances are included in the investigation, are as follows :—

TABLE 109.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1847 ...	+ ·00234	+ ·00050	+ ·00029	+ ·00025	+ ·00086	+ ·00122	+ ·00079	+ ·00065	− ·00148	− ·00112	− ·00158	− ·00263
1848 ...	− ·00176	− ·00097	+ ·00007	+ ·00068	+ ·00133	+ ·00187	+ ·00025	+ ·00076	+ ·00349	− ·00148	− ·00274	− ·00169
1849 ...	− ·00086	− ·00050	+ ·00086	+ ·00137	+ ·00158	+ ·00025	·00000	+ ·00004	− ·00068	− ·00079	− ·00122	− ·00018
1850 ...	·00000	+ ·00036	+ ·00122	+ ·00144	+ ·00148	+ ·00079	− ·00047	− ·00036	− ·00097	− ·00133	− ·00079	− ·00155
1852 ...	+ ·00014	− ·00194	+ ·00029	− ·00022	+ ·00122	+ ·00104	+ ·00072	+ ·00065	− ·00097	− ·00014	− ·00025	− ·00061
1853 ...	+ ·00011	+ ·00015	+ ·00077	+ ·00109	+ ·00040	+ ·00022	− ·00047	+ ·00033	− ·00204	+ ·00040	− ·00018	− ·00077
1854 ...	+ ·00044	+ ·00040	+ ·00044	− ·00069	+ ·00055	+ ·00106	− ·00040	− ·00036	− ·00106	− ·00062	+ ·00011	+ ·00026
1855 ...	+ ·00095	+ ·00044	+ ·00077	+ ·00066	+ ·00066	+ ·00047	− ·00088	− ·00088	− ·00073	− ·00117	− ·00040	+ ·00029
1860 ...	+ ·00180	+ ·00331	+ ·00022	− ·00112	− ·00045	− ·00011	− ·00146	− ·00286	− ·00224	− ·00067	+ ·00180	+ ·00151
1861 ...	+ ·00190	+ ·00168	+ ·00134	+ ·00196	+ ·00207	− ·00123	− ·00034	− ·00123	− ·00207	− ·00185	− ·00106	− ·00140
1862 ...	+ ·00162	+ ·00228	+ ·00212	+ ·00173	+ ·00150	+ ·00178	− ·00061	− ·00262	− ·00217	− ·00412	− ·00123	− ·00050
1863 ...	+ ·00072	+ ·00111	+ ·00228	+ ·00117	+ ·00178	+ ·00056	− ·00067	− ·00172	− ·00250	− ·00172	− ·00033	− ·00033
1864 ...	+ ·00183	+ ·00194	+ ·00111	+ ·00039	− ·00050	− ·00150	− ·00183	− ·00239	− ·00261	− ·00011	+ ·00166	+ ·00211
1865 ...	+ ·00061	+ ·00144	+ ·00238	+ ·00188	+ ·00183	+ ·00078	− ·00006	− ·00460	− ·00222	− ·00294	− ·00089	− ·00161
1867 ...	+ ·00160	+ ·00199	+ ·00083	+ ·00094	+ ·00072	+ ·00017	− ·00083	− ·00188	− ·00304	− ·00238	+ ·00055	+ ·00171
1868 ...	+ ·00226	+ ·00155	+ ·00155	+ ·00017	+ ·00077	+ ·00044	− ·00083	− ·00110	− ·00293	− ·00254	+ ·00033	+ ·00028
1869 ...	+ ·00104	+ ·00071	+ ·00093	− ·00066	− ·00033	+ ·00055	+ ·00082	− ·00126	− ·00280	− ·00121	+ ·00115	+ ·00132
1870 ...	− ·00044	− ·00022	+ ·00060	+ ·00011	+ ·00203	+ ·00192	+ ·00209	− ·00027	− ·00302	− ·00313	− ·00088	+ ·00137
1871 ...	+ ·00060	− ·00005	+ ·00044	− ·00192	+ ·00187	+ ·00159	+ ·00022	− ·00104	− ·00088	− ·00077	− ·00187	− ·00159
1872 ...	+ ·00241	+ ·00066	+ ·00049	+ ·00126	+ ·00302	+ ·00137	− ·00027	− ·00209	− ·00192	− ·00313	− ·00060	− ·00132
1847 to 1850 ...	− ·00007	− ·00015	+ ·00061	+ ·00093	+ ·00136	+ ·00103	+ ·00014	+ ·00027	+ ·00009	− ·00118	− ·00158	− ·00151
1852 to 1855 ...	+ ·00041	− ·00024	+ ·00057	+ ·00021	+ ·00071	+ ·00070	− ·00026	− ·00006	− ·00120	− ·00038	− ·00018	− ·00021
1860 to 1865 ...	+ ·00141	+ ·00196	+ ·00157	+ ·00100	+ ·00104	+ ·00005	− ·00083	− ·00257	− ·00230	− ·00190	− ·00001	− ·00004
1867 to 1872 ...	+ ·00124	+ ·00077	+ ·00081	− ·00002	+ ·00135	+ ·00101	+ ·00020	− ·00127	− ·00243	− ·00219	− ·00022	+ ·00082
1847 to 1872 ...	+ ·00091	+ ·00074	+ ·00095	+ ·00052	+ ·00112	+ ·00066	− ·00022	− ·00111	− ·00164	− ·00154	− ·00042	− ·00011



238. Absolute determinations of the horizontal force are available from 1868 onward, and after correction for the difference—shown by Grubb's horizontal force magnetometer—between the force at the time of observation and the mean force of the month, may be used as partly independent data from which to deduce the annual variation of horizontal force. The monthly means of the determinations so corrected are shown in Table 110.

TABLE 110.

(In British units.)

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.	Annual increment.
1868	8·0556	8·0491	8·0551	8·0606	8·0578	8·0602	8·0617	8·0444	8·0568	8·0573	8·0612	8·0554	8·0563	
1869	8·0584	8·0680	8·0629	8·0552	8·0524	8·0592	8·0613	8·0580	8·0619	8·0576	8·0671	8·0582	8·0600	+·0037
1870	8·0581	8·0610	8·0654	8·0627	8·0611	8·0708	8·0702	8·0672	8·0642	8·0604	8·0630	8·0685	8·0644	+·0044
1871	8·0674	8·0681	8·0673	8·0628	8·0658	8·0705	8·0735	8·0713	8·0718	8·0752	8·0657	8·0662	8·0688	+·0044
1872	8·0668	8·0643	8·0718	8·0770	8·0793	8·0791	8·0746	8·0715	8·0744	8·0691	8·0707	8·0752	8·0728	+·0040
1873	8·0725	8·0727	8·0757	8·0802	8·0816	8·0809	8·0833	8·0822	8·0791	8·0809	8·0793	8·0814	8·0791	+·0063
1874	8·0836	8·0776	8·0789	8·0849	8·0862	8·0873	8·0866	8·0894	8·0875	8·0889	8·0863	8·0879	8·0854	+·0063
1875	8·0874	8·0845	8·0878	8·0918	8·0925	8·0933	8·0934	8·0918	8·0901	8·0953	8·0958	8·0916	8·0913	+·0059
1876	8·0899	8·0921	8·0928	8·0962	8·0983	8·0981	8·0977	8·0985	8·0991	8·0985	8·0973	8·0955	8·0962	+·0049
1877	8·0966	8·0987	8·0984	8·0989	8·0963	8·0946	8·0985	8·0987	8·0978	8·0989	8·0997	8·0996	8·0981	+·0019
1878	8·0999	8·0993	8·1021	8·1000	8·0976	8·0987	8·1032	8·1033	8·1011	8·1014	8·1028	8·1034	8·1011	+·0030
1879	8·1020	8·1041	8·1037	8·1057	8·1031	8·1051	8·1062	8·1048	8·1026	8·1043	8·1014	8·1013	8·1037	+·0026
1880	8·1051	8·1080	8·1043	8·1089	8·1048	8·1044	8·1055	8·0982	8·1001	8·0987	8·0985	8·1011	8·1031	−·0006
1881	8·1021	8·1011	8·1011	8·0987	8·1029	8·1032	8·1046	8·1040	8·1004	8·1023	8·0995	8·0988	8·1016	−·0015

239. The monthly means of these numbers were taken for the periods 1868 to 1872, 1873 to 1881, and 1868 to 1881, and the change of mean force from the first to the last year of each period, divided by the number of years, was taken as the annual rate at which secular increase should be allowed for from month to month; after such allowance the variations were taken, and converted into *mm-mg-s* units of force, with the results shown in Table 111:—

TABLE 111.

Period.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1868 to 1872...	−·00055	−·00037	+·00060	+·00005	−·00028	+·00171	+·00171	−·00115	+·00023	−·00078	−·00023	−·00074
1873 to 1881...	−·00046	−·00065	−·00037	+·00055	+·00032	+·00037	+·00097	+·00041	−·00037	+·00014	−·00046	−·00055
1868 to 1881...	−·00046	−·00051	·00000	+·00037	+·00014	+·00088	+·00124	−·00014	−·00014	−·00023	−·00037	−·00065

240. The numbers of this table are curved in Figs. 546 to 548. They are, of course, less regular than those of Table 108, and, so far as they indicate a systematic variation at all, it is of less range and different in character from that indicated by the numbers of Table 108. Here there is a tendency, in both periods, to a maximum about the middle of the year and a minimum about the end of the year, whilst the main features of Figs. 541 to 545 are a maximum about the vernal equinox and a minimum about the autumnal equinox. In the latter case the range is, however, much smaller in the early periods (Figs. 542 and 543) than in the later periods (Figs. 544 and 545). The only apparent way of reconciling the two unlike variations is to suppose that at the top of the Electrometer Tower, where the absolute determinations are made, the magnetic field is subject to a different annual variation from that of the magnetic observatory below, where the horizontal force magnetometer is placed. Failing this, the magnetometer must be regarded as subject to unknown non-magnetic influences which have a systematic annual variation.

241. *Secular change.*—In paragraphs 198 and 235 we found the annual increments of horizontal force at different epochs, when disturbances were included and excluded respectively, to be as shown in the following table:—

TABLE 112.

At Epoch.	Including Disturbances.		Excluding Disturbances.	
	Scale-division.	Unit of force.	Scale-division.	Unit of force.
1849·0 ...	2·04	·0073	1·97	·0071
1852·25 ...	2·02	·0073	1·95	·0070
1854·5 ...	1·37	·0050	1·34	·0049
1863·0 ...	0·57	·0032	0·56	·0031
1870·0 ...	0·30	·0016	0·44	·0024

The annual mean values of absolute horizontal force given in the last column but one of Table 110, show that the average annual increments, in successive periods, were as follows:—

	British Units.	*mm-mg-s.* Units.
From 1868 to 1872 ...	+·0041	+·0019
„ 1872 to 1876 ...	+·0058	+·0027
„ 1876 to 1879 ...	+·0025	+·0012
„ 1879 to 1881 ...	−·0010	−·0005

It thus appears that the rate of increase, which had been diminishing since 1847, increased from the first to the second of these periods, reaching a maximum about the beginning of 1874, and then began again to decrease, which it has continued to do ever since. It will be noticed that the force itself was—like the easterly declination—a maximum in the year 1879 and that the diminution which followed has continued ever since.

242. *Lunar diurnal variation.*—The data used for this investigation are the observations of the twenty-six and a half years 1846·5 to 1873·0. The method of treatment adopted was to form from the monthly abstracts, tables of lunar differences, and then lunar abstracts in the manner described in paragraph 160, the numbers operated upon being throughout scale-readings of Grubb's horizontal force magnetometer. The separating values used—the equivalents of ·00334 of force—are those shown in paragraph 177; and the constant number by which the final normals were diminished, in order to avoid positive and negative differences, was 1·00 sc. div.

243. The following tables show the hourly excesses found on each of the forty-eight lunar abstracts:

TABLE 113.

NORTH.

Declination of Moon.		New.		First Quarter.			Full.		Last Quarter.		
Phase of Moon.											
Bombay Lunar Hour.*		February to April.	May to July.	August to October.	November to January.	February to April.	May to July.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.
		1	2	3	4	5	6	7	8	9	10	11	12
0	...	-·00003	-·00004	+·00001	-·00009	+·00006	+·00011	+·00006	+·00013	+·00015	+·00001	-·00001	-·00001
1	...	-·00004	-·00017	+·00005	-·00021	·00000	+·00013	+·00008	+·00002	-·00009	-·00001	-·00007	-·00001
2	...	-·00005	-·00011	-·00007	+·00013	-·00004	-·00015	-·00007	-·00001	-·00013	-·00006	-·00008	-·00006
3	...	-·00016	-·00015	-·00031	+·00003	+·00001	-·00026	-·00008	-·00010	-·00020	-·00008	-·00002	-·00018
4	...	-·00015	-·00014	-·00024	+·00014	-·00006	-·00021	-·00003	+·00001	-·00001	-·00003	+·00010	-·00017
5	...	-·00007	-·00008	+·00011	+·00005	-·00006	-·00013	+·00001	+·00010	+·00018	+·00007	+·00010	-·00009
6	...	-·00012	-·00003	+·00017	+·00013	·00000	-·00010	+·00006	+·00010	+·00009	+·00029	-·00011	-·00015
7	...	-·00022	+·00005	+·00023	+·00023	+·00003	-·00013	+·00012	+·00012	+·00020	+·00027	-·00020	+·00003
8	...	-·00025	+·00002	+·00002	+·00013	+·00002	-·00007	+·00023	+·00001	+·00008	+·00034	-·00001	+·00010
9	...	-·00023	-·00004	+·00006	+·00028	+·00003	-·00004	+·00029	+·00010	+·00003	+·00022	-·00012	+·00012
10	...	-·00014	-·00006	-·00007	+·00029	+·00007	-·00010	+·00021	+·00007	+·00003	+·00026	·00000	+·00007
11	...	-·00002	-·00001	+·00010	+·00010	+·00001	-·00003	+·00009	+·00004	-·00012	+·00007	+·00007	+·00007
12	...	·00000	+·00001	+·00009	+·00013	-·00001	+·00006	-·00004	+·00002	-·00019	-·00001	+·00004	+·00004
13	...	-·00014	+·00001	+·00005	-·00007	-·00009	-·00001	-·00012	-·00013	+·00007	+·00004	-·00017	+·00012
14	...	+·00002	·00000	+·00010	-·00032	-·00029	-·00012	-·00022	-·00034	+·00001	-·00005	+·00005	+·00002
15	...	+·00007	-·00002	-·00003	-·00029	-·00026	-·00018	-·00026	-·00017	+·00003	-·00028	+·00003	·00000
16	...	-·00004	+·00007	+·00007	-·00026	-·00017	+·00015	-·00021	-·00022	-·00018	-·00025	+·00003	+·00001
17	...	+·00012	+·00007	+·00010	-·00013	-·00008	+·00005	-·00005	+·00019	-·00012	-·00029	-·00004	+·00002
18	...	+·00042	·00000	·00000	-·00010	-·00002	+·00003	-·00011	+·00005	-·00004	-·00018	+·00001	-·00004
19	...	+·00031	+·00016	-·00010	-·00010	+·00001	+·00003	-·00006	-·00017	-·00007	-·00027	+·00010	+·00003
20	...	+·00024	+·00012	+·00005	+·00003	+·00008	+·00016	-·00001	-·00007	-·00009	-·00014	+·00011	-·00004
21	...	+·00020	+·00014	+·00006	-·00012	+·00019	+·00031	-·00003	-·00006	-·00001	+·00006	+·00006	+·00002
22	...	+·00034	+·00008	-·00017	-·00012	+·00014	+·00025	-·00001	+·00004	+·00014	+·00005	+·00022	+·00004
23	..	+·00022	+·00011	-·00024	+·00009	+·00017	+·00016	+·00006	+·00018	+·00017	-·00004	-·00004	+·00008
Coefficients.	A_1	+·00011	-·00001	-·00009	-·00003	+·00006	+·00006	·00000	+·00005	+·00002	-·00004	+·00003	-·00005
	B_1	+·00017	-·00009	+·00001	+·00017	+·00004	-·00012	+·00011	+·00007	+·00005	+·00019	-·00005	-·00003
	A_2	-·00004	-·00003	-·00003	-·00001	+·00003	+·00004	+·00001	-·00001	-·00001	+·00002	·00000	+·00005
	B_2	-·00005	-·00007	-·00002	-·00011	-·00001	-·00010	-·00013	-·00007	-·00006	-·00013	-·00001	-·00006
	A_3	-·00003	·00000	+·00004	-·00003	-·00001	+·00002	+·00004	+·00004	+·00005	+·00002	-·00005	+·00003
	B_3	-·00001	-·00003	-·00004	+·00005	-·00001	-·00003	+·00005	+·00003	-·00010	-·00005	-·00001	·00000
Number of lunar days' observations in abstract.		33	331	72	43	319	67	304	63	30	79	45	330

*The lunar day is reckoned as beginning at the moment of the moon's upper passage of the meridian.

Table 114.

Declination of Moon.	Changing from North to South.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hour.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.	November to January.	February to April.	May to July.	November to January.	February to April.	August to October.
	1	2	3	4	5	6	7	8	9	10	11	12
0 ...	−·00003	+·00003	−·00007	−·00013	·00000	−·00009	−·00014	−·00006	−·00005	−·00006	−·00014	+·00014
1 ...	−·00011	+·00013	+·00001	−·00006	+·00001	−·00024	+·00003	−·00007	−·00003	−·00011	−·00010	−·00008
2 ...	−·00038	+·00013	−·00007	−·00017	−·00003	−·00026	−·00001	−·00007	−·00005	−·00020	+·00001	−·00018
3 ...	−·00035	+·00017	−·00010	−·00002	−·00004	−·00018	−·00001	−·00012	−·00023	−·00031	−·00001	−·00024
4 ...	−·00032	−·00002	−·00003	−·00011	−·00002	−·00030	−·00002	−·00003	−·00013	−·00024	−·00012	−·00035
5 ...	−·00011	+·00009	·00000	−·00017	−·00004	−·00026	−·00003	+·00001	−·00009	−·00008	−·00017	−·00028
6 ...	−·00005	+·00001	−·00007	−·00005	+·00002	−·00021	+·00011	+·00010	−·00007	+·00012	−·00017	−·00033
7 ...	−·00013	+·00007	−·00012	−·00005	−·00002	−·00012	+·00027	+·00016	+·00009	+·00029	+·00022	−·00021
8 ...	−·00023	−·00003	−·00004	−·00009	−·00007	+·00005	+·00044	+·00024	+·00009	+·00033	+·00012	−·00015
9 ...	+·00002	+·00006	·00000	−·00005	−·00004	+·00019	+·00059	+·00017	+·00015	+·00027	+·00003	+·00005
10 ...	−·00001	+·00001	+·00003	·00000	+·00002	+·00009	+·00030	+·00018	+·00009	+·00024	−·00005	·00000
11 ...	+·00015	+·00009	−·00002	+·00007	−·00001	+·00003	+·00021	+·00013	−·00010	+·00012	+·00014	+·00023
12 ...	+·00009	−·00012	+·00002	+·00015	+·00001	−·00007	+·00012	+·00016	+·00007	+·00007	−·00005	+·00017
13 ...	+·00006	+·00004	+·00006	·00000	·00000	−·00010	+·00002	+·00005	+·00005	+·00010	+·00005	+·00005
14 ...	−·00005	−·00006	+·00006	−·00003	−·00007	−·00006	−·00023	−·00009	−·00010	−·00001	+·00005	+·00017
15 ...	+·00012	−·00011	+·00007	−·00022	−·00006	+·00010	−·00038	−·00010	·00000	−·00009	−·00005	+·00064
16 ...	+·00012	−·00019	+·00002	+·00022	·00000	+·00015	−·00029	−·00006	−·00008	−·00002	·00000	+·00007
17 ...	+·00013	−·00021	+·00008	+·00011	−·00007	+·00027	−·00034	−·00006	−·00021	−·00006	−·00004	+·00012
18 ...	+·00014	+·00004	+·00009	+·00013	−·00002	+·00016	−·00034	−·00012	−·00009	−·00001	+·00004	+·00013
19 ...	+·00007	−·00012	+·00001	+·00009	+·00003	+·00029	−·00005	−·00016	+·00001	−·00007	−·00014	+·00014
20 ...	+·00015	−·00010	+·00002	−·00014	+·00006	+·00014	−·00013	−·00007	+·00016	−·00002	−·00011	+·00011
21 ...	+·00013	+·00015	+·00012	+·00009	+·00014	+·00022	−·00025	−·00001	+·00016	−·00001	+·00008	+·00007
22 ...	+·00016	−·00007	+·00004	+·00011	+·00012	+·00010	+·00003	−·00004	+·00013	−·00006	+·00018	+·00019
23 ...	+·00015	+·00001	+·00001	+·00024	+·00004	+·00008	+·00002	−·00005	+·00013	−·00010	+·00015	+·00008
Coefficients. A_1	−·00007	+·00005	−·00002	−·00002	+·00003	−·00005	−·00008	−·00008	·00000	−·00014	−·00003	−·00006
B_1	−·00015	+·00008	−·00006	−·00008	−·00002	−·00018	+·00024	+·00009	−·00001	+·00005	−·00001	−·00019
A_2	+·00001	+·00003	·00000	+·00001	+·00001	−·00005	+·00005	+·00001	+·00003	−·00002	+·00003	+·00010
B_2	−·00011	−·00001	−·00001	−·00004	−·00004	−·00013	−·00018	−·00008	−·00012	−·00014	−·00005	−·00008
A_3	+·00002	−·00002	−·00001	·00000	−·00002	+·00004	+·00002	+·00001	+·00001	+·00006	+·00004	+·00001
B_3	−·00004	+·00002	−·00001	+·00001	−·00002	+·00004	+·00005	−·00001	−·00004	−·00002	−·00003	+·00002
Number of lunar days' observations in abstract.	87	54	351	54	372	98	50	323	85	345	77	46

Table 115.

Declination of Moon.	South.											
Phase of Moon.	New.			First Quarter.			Full.			Last Quarter.		
Bombay Lunar Hours.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.	November to January.	February to April.	May to July.
	1	2	3	4	5	6	7	8	9	10	11	12
0 ...	−·00011	−·00016	−·00015	−·00012	−·00012	−·00003	+·00007	+·00006	+·00001	−·00016	−·00011	−·00010
1 ...	−·00019	−·00033	−·00019	−·00018	−·00008	+·00002	+·00008	+·00002	+·00013	−·00037	−·00009	−·00010
2 ...	−·00028	−·00030	−·00018	−·00009	+·00002	−·00004	+·00019	+·00004	+·00015	−·00070	−·00007	−·00007
3 ...	−·00029	−·00027	+·00008	+·00001	+·00001	−·00004	+·00027	+·00001	+·00013	−·00045	−·00003	+·00016
4 ...	−·00014	−·00032	+·00013	+·00021	+·00006	−·00005	+·00008	+·00007	+·00009	−·00037	−·00006	−·00011
5 ...	−·00008	−·00016	+·00005	+·00014	+·00005	−·00005	−·00008	+·00006	+·00004	−·00003	−·00009	+·00003
6 ...	−·00003	+·00019	−·00002	−·00008	+·00008	−·00009	+·00010	+·00003	+·00006	−·00011	+·00004	·00000
7 ...	+·00004	+·00014	−·00001	−·00007	−·00008	−·00004	+·00025	+·00005	+·00015	−·00015	−·00004	−·00005
8 ...	−·00001	+·00018	+·00012	+·00008	−·00010	−·00002	+·00018	+·00002	·00000	+·00021	−·00003	+·00005
9 ...	+·00006	+·00010	−·00003	+·00010	+·00013	+·00006	+·00033	+·00007	+·00001	+·00029	·00000	+·00009
10 ..	+·00002	+·00005	+·00002	+·00024	+·00017	+·00003	+·00048	+·00006	−·00010	+·00025	−·00001	+·00001
11 ...	·00000	+·00012	−·00007	+·00016	+·00004	−·00002	+·00010	+·00011	−·00002	+·00030	+·00005	−·00001
12 ...	−·00002	+·00009	+·00010	+·00010	−·00002	−·00002	+·00012	+·00006	−·00031	+·00025	−·00002	−·00018
13 ...	−·00003	+·00018	+·00012	+·00003	−·00003	−·00013	−·00009	+·00001	−·00026	+·00017	+·00006	+·00007
14 ...	−·00007	+·00022	−·00011	−·00008	−·00011	−·00014	−·00028	−·00004	−·00042	+·00010	+·00007	−·00005
15 ...	−·00004	+·00010	+·00003	−·00007	+·00010	−·00014	−·00022	−·00008	−·00031	−·00001	+·00008	−·00002
16 ...	+·00002	−·00007	+·00006	−·00008	+·00012	−·00005	−·00031	−·00007	−·00010	+·00023	+·00004	−·00006
17 ...	+·00003	−·00011	+·00028	−·00015	−·00035	+·00002	−·00037	−·00005	+·00005	+·00009	·00000	−·00006
18 ...	+·00007	−·00006	+·00017	−·00014	−·00013	+·00015	−·00028	−·00006	−·00001	+·00011	+·00005	+·00011
19 ...	+·00015	+·00009	−·00003	−·00011	−·00022	+·00018	−·00014	−·00003	+·00001	+·00003	+·00014	+·00014
20 ...	+·00024	+·00019	−·00048	−·00007	+·00007	+·00009	−·00004	−·00006	+·00024	+·00012	+·00006	+·00013
21 ...	+·00028	+·00027	+·00021	−·00008	+·00012	+·00011	−·00019	−·00007	+·00006	+·00006	+·00002	−·00007
22 ...	+·00021	−·00003	−·00003	+·00007	+·00013	+·00016	−·00015	−·00006	+·00018	+·00013	−·00003	−·00004
23 ...	+·00015	−·00021	−·00002	+·00009	+·00016	+·00008	−·00005	−·00007	+·00022	−·00004	−·00006	+·00005
Coefficients. A_1	−·00001	−·00016	−·00005	−·00005	+·00001	+·00001	−·00001	−·00002	+·00018	−·00024	−·00005	·00000
B_1	·00000	−·00005	·00000	+·00008	+·00004	−·00005	+·00024	+·00006	+·00005	−·00012	−·00005	−·00001
A_2	−·00004	−·00003	−·00005	+·00004	+·00004	−·00002	+·00007	+·00002	−·00006	·00000	−·00002	−·00004
B_2	−·00015	−·00013	+·00003	−·00004	−·00004	−·00008	−·00009	·00000	−·00008	−·00018	−·00001	−·00003
A_3	−·00001	−·00003	+·00001	−·00005	−·00002	−·00001	−·00001	−·00001	+·00001	+·00001	−·00002	−·00002
B_3	−·00006	−·00010	−·00001	·00000	−·00005	+·00004	+·00002	+·00002	+·00004	−·00004	·00000	+·00002
Number of lunar days' observations in abstract.	302	56	32	86	50	338	35	328	62	46	321	71

TABLE 116.

Declination of Moon.	Changing from South to North.																							
Phase of Moon.	Now.				First Quarter.				Full.				Last Quarter.											
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	November to January.	February to April.	August to October.	November to January.	May to July.	August to October.	February to April.	May to July.	August to October.											
	1	2	3	4	5	6	7	8	9	10	11	12												
0 ...	+ ·00022	− ·00005	− ·00021	+ ·00002	·00000	+ ·00011	+ ·00013	+ ·00001	− ·00007	− ·00007	− ·00004	− ·00002												
1 ...	− ·00011	− ·00007	·00000	+ ·00005	− ·00004	+ ·00006	+ ·00021	− ·00004	− ·00001	− ·00010	− ·00008	− ·00003												
2 ...	− ·00023	− ·00011	− ·00013	+ ·00005	+ ·00004	− ·00002	+ ·00012	− ·00003	− ·00013	− ·00029	− ·00006	+ ·00002												
3 ...	− ·00049	− ·00014	+ ·00004	− ·00002	+ ·00006	− ·00012	+ ·00012	+ ·00011	− ·00010	− ·00009	+ ·00003	+ ·00007												
4 ...	− ·00029	− ·00021	+ ·00016	+ ·00005	·00000	+ ·00004	− ·00002	+ ·00009	− ·00006	− ·00009	− ·00002	+ ·00010												
5 ...	− ·00014	− ·00013	+ ·00010	+ ·00001	+ ·00009	·00000	+ ·00008	+ ·00022	·00000	− ·00020	+ ·00001	+ ·00011												
6 ...	− ·00010	− ·00009	+ ·00003	·00000	+ ·00002	+ ·00006	− ·00001	+ ·00011	+ ·00001	− ·00045	− ·00005	− ·00008												
7 ...	− ·00018	− ·00005	− ·00007	+ ·00002	− ·00008	+ ·00010	− ·00001	+ ·00008	− ·00002	+ ·00005	− ·00003	+ ·00007												
8 ...	+ ·00003	·00000	− ·00006	+ ·00004	+ ·00009	+ ·00022	+ ·00014	+ ·00010	+ ·00006	− ·00009	+ ·00004	− ·00002												
9 ...	+ ·00004	+ ·00001	− ·00001	+ ·00007	+ ·00008	+ ·00016	+ ·00003	− ·00004	+ ·00015	− ·00021	+ ·00004	+ ·00018												
10 ...	+ ·00006	+ ·00006	+ ·00006	+ ·00005	+ ·00003	+ ·00012	+ ·00019	− ·00023	+ ·00011	− ·00016	− ·00001	+ ·00010												
11 ...	− ·00005	− ·00001	+ ·00010	+ ·00008	+ ·00006	+ ·00016	+ ·00008	− ·00017	+ ·00001	+ ·00008	+ ·00001	+ ·00009												
12 ...	− ·00015	+ ·00009	+ ·00007	− ·00001	+ ·00005	+ ·00029	− ·00017	− ·00014	+ ·00004	+ ·00004	− ·00002	+ ·00016												
13 ...	− ·00012	+ ·00005	+ ·00002	− ·00010	− ·00002	+ ·00031	− ·00007	− ·00034	+ ·00003	+ ·00001	− ·00001	+ ·00007												
14 ...	− ·00018	+ ·00001	+ ·00006	− ·00015	− ·00008	+ ·00022	− ·00027	− ·00012	− ·00006	+ ·00003	+ ·00003	+ ·00003												
15 ...	− ·00006	+ ·00001	+ ·00018	− ·00029	− ·00023	− ·00007	− ·00026	− ·00001	− ·00006	+ ·00006	+ ·00017	+ ·00006												
16 ...	+ ·00001	− ·00007	+ ·00011	− ·00024	− ·00024	− ·00010	− ·00015	·00000	− ·00003	− ·00003	+ ·00012	+ ·00011												
17 ...	+ ·00003	− ·00001	+ ·00007	− ·00022	− ·00040	− ·00007	− ·00031	·00000	− ·00001	+ ·00021	+ ·00021	+ ·00004												
18 ...	+ ·00031	+ ·00005	− ·00005	− ·00006	− ·00014	− ·00024	− ·00010	+ ·00003	− ·00001	+ ·00023	+ ·00001	− ·00002												
19 ...	+ ·00034	+ ·00009	− ·00012	− ·00002	− ·00010	− ·00011	+ ·00001	+ ·00006	+ ·00006	+ ·00028	+ ·00003	− ·00019												
20 ...	+ ·00039	+ ·00013	− ·00008	+ ·00015	+ ·00021	− ·00030	+ ·00009	+ ·00017	+ ·00005	+ ·00027	+ ·00003	− ·00017												
21 ...	+ ·00028	+ ·00019	− ·00008	+ ·00017	+ ·00025	− ·00010	+ ·00009	+ ·00012	·00000	+ ·00026	+ ·00003	− ·00017												
22 ...	+ ·00020	+ ·00016	− ·00011	+ ·00014	+ ·00017	− ·00030	+ ·00018	− ·00002	+ ·00002	+ ·00003	− ·00001	− ·00009												
23 ...	+ ·00022	+ ·00011	− ·00015	+ ·00013	+ ·00009	− ·00030	− ·00004	− ·00007	+ ·00005	− ·00004	+ ·00002	− ·00027												
Coefficients. A_1	+ ·00006	− ·00001	− ·00008	+ ·00008	+ ·00007	− ·00016	+ ·00008	+ ·00009	− ·00003	− ·00002	− ·00002	− ·00008												
B_1	− ·00019	− ·00008	+ ·00002	+ ·00006	+ ·00007	+ ·00012	+ ·00008	+ ·00002	·00000	− ·00021	− ·00021	+ ·00006												
A_2	− ·00003	+ ·00003	+ ·00002	+ ·00004	+ ·00006	+ ·00008	+ ·00004	− ·00001	+ ·00012	− ·00004	− ·00004	− ·00002												
B_2	− ·00020	− ·00009	+ ·00007	− ·00011	− ·00011	+ ·00003	+ ·00009	− ·00001	− ·00007	− ·00004	− ·00001	+ ·00008												
A_3	+ ·00003	− ·00001	− ·00003	− ·00005	− ·00009	·00000	− ·00002	+ ·00005	·00000	− ·00004	·00000	·00000												
B_3	− ·00005	− ·00002	·00000	·00000	− ·00004	− ·00003	+ ·00005	− ·00002	+ ·00001	+ ·00001	·00000	+ ·00002												
Number of lunar days' observations in abstract.	49	328	85	331	86	56	89	55	359	53	362	98												

244. The last six numbers but one in the several columns show the values of the coefficients, derived from the respective sets of hourly excesses in the series

$$\delta\theta = A_1 \cos\theta + B_1 \sin\theta + A_2 \cos 2\theta + B_2 \sin 2\theta + \&c:$$

in which θ represents the hour angle and $\delta\theta$ the excess for the corresponding hour.

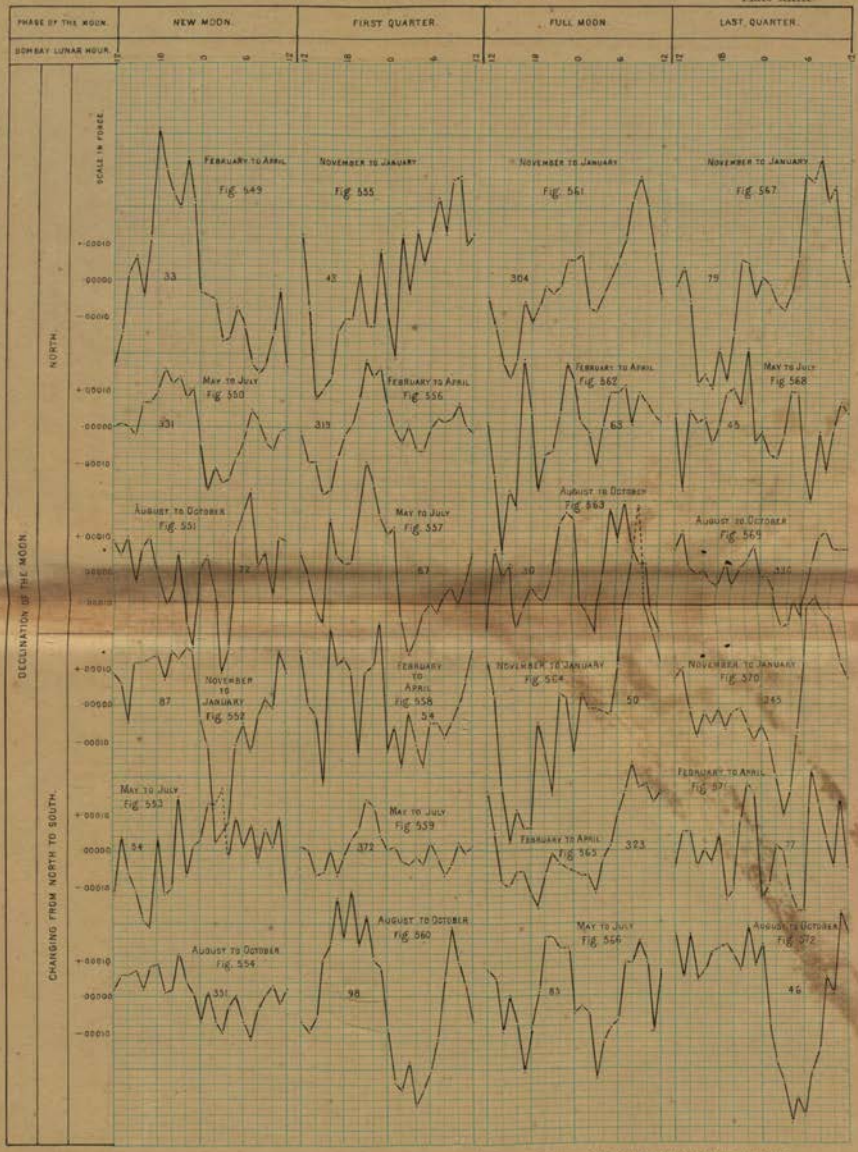
Curves have been constructed, in the usual manner, to represent these variations, and appear as Figs. 549 to 596 on Plate XXIX.

245. By means of the sums and numbers of days marked at the feet of the lunar abstracts combinations were also made first irrespective of the moon's declination, and then irrespective of the phases of the moon. The results—giving the mean excesses for all the days for which entries of lunar differences are found—are shown in Tables 117 to 120.

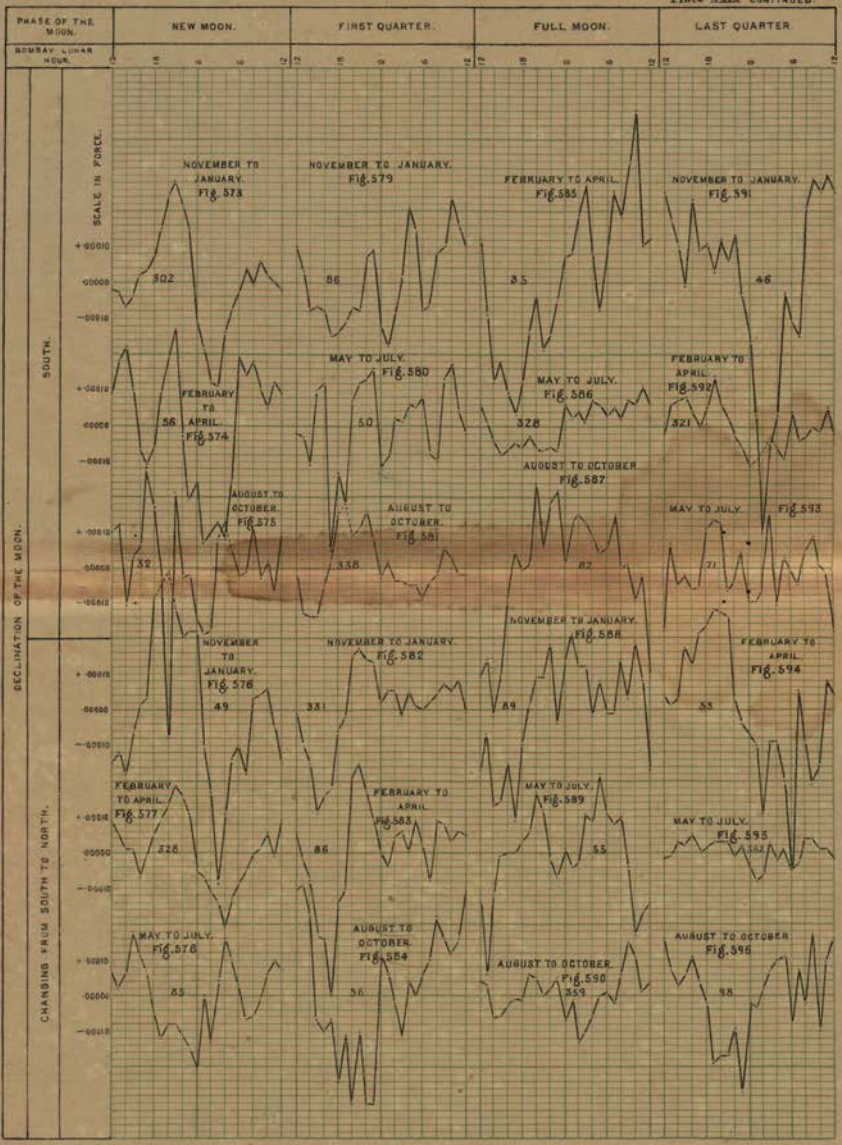
COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF HORIZONTAL FORCE.

Plate XXIX.



THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.



THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.

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Table 117.

Phase of Moon.	New.							First Quarter.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0 ...	− ·00006	− ·00006	− ·00007	− ·00006	− ·00007	− ·00005	− ·00006	− ·00001	+ ·00003	+ ·00001	− ·00004	·00000	− ·00001	·00000
1 ...	− ·00016	− ·00010	− ·00011	·00000	− ·00009	− ·00009	− ·00009	− ·00001	− ·00001	+ ·00002	− ·00004	− ·00001	− ·00001	·00000
2 ...	− ·00029	− ·00013	− ·00009	− ·00008	− ·00009	− ·00020	− ·00014	+ ·00003	− ·00003	− ·00003	− ·00009	− ·00005	− ·00001	− ·00002
3 ...	− ·00033	− ·00015	− ·00009	− ·00012	− ·00013	− ·00021	− ·00017	− ·00001	+ ·00002	− ·00006	− ·00008	− ·00006	− ·00001	− ·00003
4 ...	− ·00019	− ·00022	− ·00007	− ·00004	− ·00010	− ·00016	− ·00013	+ ·00009	− ·00005	− ·00003	− ·00011	− ·00007	+ ·00003	− ·00002
5 ...	− ·00009	− ·00013	− ·00003	+ ·00003	− ·00002	− ·00008	− ·00005	+ ·00004	− ·00004	− ·00004	− ·00010	− ·00008	+ ·00001	− ·00003
6 ...	− ·00003	− ·00005	− ·00002	− ·00003	− ·00002	− ·00005	− ·00003	·00000	·00000	+ ·00002	− ·00010	− ·00004	·00000	− ·00002
7 ...	− ·00001	− ·00004	+ ·00003	− ·00004	+ ·00002	− ·00002	− ·00002	+ ·00002	·00000	− ·00003	− ·00005	− ·00005	+ ·00002	− ·00001
8 ...	·00000	+ ·00001	− ·00001	− ·00001	− ·00001	·00000	·00000	+ ·00006	+ ·00002	− ·00007	+ ·00001	− ·00004	+ ·00005	+ ·00001
9 ...	+ ·00005	+ ·00001	+ ·00003	+ ·00001	− ·00001	+ ·00003	+ ·00001	+ ·00009	+ ·00004	− ·00002	+ ·00009	+ ·00003	+ ·00007	+ ·00005
10 ...	+ ·00003	+ ·00005	− ·00004	+ ·00001	− ·00002	+ ·00004	+ ·00001	+ ·00010	+ ·00006	+ ·00002	+ ·00004	+ ·00003	+ ·00008	+ ·00006
11 ...	+ ·00003	+ ·00001	+ ·00002	− ·00001	+ ·00001	+ ·00001	+ ·00001	+ ·00010	+ ·00003	− ·00001	·00000	− ·00001	+ ·00007	+ ·00004
12 ...	− ·00001	+ ·00007	− ·00001	+ ·00004	+ ·00003	+ ·00002	+ ·00003	+ ·00003	+ ·00002	+ ·00002	− ·00001	− ·00001	+ ·00003	+ ·00002
13 ...	− ·00002	+ ·00006	+ ·00001	+ ·00006	+ ·00004	+ ·00002	+ ·00003	− ·00007	− ·00007	·00000	+ ·00012	− ·00007	− ·00004	− ·00005
14 ...	− ·00008	+ ·00004	·00000	+ ·00005	+ ·00003	− ·00003	+ ·00001	− ·00015	− ·00008	− ·00008	− ·00009	− ·00010	− ·00010	− ·00010
15 ...	− ·00001	+ ·00003	·00000	+ ·00005	+ ·00003	+ ·00001	+ ·00002	− ·00025	− ·00020	− ·00005	− ·00010	− ·00010	− ·00020	− ·00014
16 ...	+ ·00004	− ·00007	+ ·00004	+ ·00003	+ ·00003	− ·00001	+ ·00002	− ·00021	− ·00014	+ ·00004	− ·00003	+ ·00001	− ·00018	− ·00008
17 ...	+ ·00005	− ·00001	+ ·00003	+ ·00010	+ ·00005	+ ·00003	+ ·00005	− ·00020	− ·00011	− ·00008	+ ·00005	·00000	− ·00017	− ·00008
18 ...	+ ·00011	+ ·00006	+ ·00006	+ ·00008	+ ·00007	+ ·00008	+ ·00008	− ·00007	− ·00002	− ·00002	+ ·00009	+ ·00004	− ·00005	·00000
19 ...	+ ·00014	+ ·00010	+ ·00007	− ·00001	+ ·00007	+ ·00008	+ ·00008	− ·00004	·00000	·00000	+ ·00015	+ ·00007	− ·00001	+ ·00003
20 ...	+ ·00023	+ ·00014	+ ·00005	− ·00003	+ ·00006	+ ·00014	+ ·00010	+ ·00010	+ ·00008	+ ·00008	+ ·00005	+ ·00007	+ ·00009	+ ·00008
21 ...	+ ·00024	+ ·00021	+ ·00009	+ ·00012	+ ·00009	+ ·00024	+ ·00016	+ ·00010	+ ·00015	+ ·00016	+ ·00010	+ ·00015	+ ·00012	+ ·00014
22 ...	+ ·00020	+ ·00015	+ ·00002	·00000	+ ·00004	+ ·00014	+ ·00009	+ ·00011	+ ·00015	+ ·00014	+ ·00008	+ ·00014	+ ·00011	+ ·00013
23 ...	+ ·00015	+ ·00008	+ ·00004	− ·00003	+ ·00001	+ ·00012	+ ·00006	+ ·00013	+ ·00017	+ ·00007	+ ·00002	+ ·00008	+ ·00011	+ ·00010
Number of lunar days' observations in abstract ...	438	417	470	455	939	861	1780	480	459	489	492	966	954	1920

Table 118.

Phase of Moon.	Full.							Last Quarter.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0 ...	+ ·00006	− ·00002	+ ·00003	− ·00005	+ ·00003	− ·00003	+ ·00001	− ·00007	− ·00011	− ·00005	·00000	− ·00005	− ·00006	− ·00005
1 ...	+ ·00010	− ·00005	·00000	·00000	+ ·00002	− ·00001	+ ·00002	− ·00012	− ·00009	− ·00009	− ·00002	− ·00007	− ·00009	− ·00008
2 ...	− ·00003	− ·00004	+ ·00001	− ·00009	·00000	− ·00007	− ·00003	− ·00023	− ·00007	− ·00007	− ·00006	− ·00008	− ·00014	− ·00011
3 ...	− ·00003	− ·00008	− ·00002	− ·00007	− ·00005	− ·00008	− ·00005	− ·00029	− ·00002	+ ·00004	− ·00013	− ·00003	− ·00018	− ·00010
4 ...	− ·00002	− ·00002	+ ·00004	− ·00004	+ ·00001	− ·00004	− ·00001	− ·00022	− ·00007	− ·00001	− ·00013	− ·00004	− ·00019	− ·00011
5 ...	+ ·00002	+ ·00001	+ ·00005	+ ·00001	+ ·00005	·00000	+ ·00003	− ·00005	− ·00011	+ ·00001	− ·00007	− ·00002	− ·00008	− ·00005
6 ...	+ ·00005	+ ·00009	+ ·00002	+ ·00002	+ ·00004	+ ·00005	+ ·00005	+ ·00012	− ·00005	− ·00006	− ·00015	− ·00008	+ ·00001	− ·00003
7 ...	+ ·00011	+ ·00015	+ ·00006	+ ·00002	+ ·00005	+ ·00011	+ ·00009	+ ·00024	+ ·00002	− ·00005	+ ·00001	− ·00001	+ ·00012	+ ·00005
8 ...	+ ·00024	+ ·00019	+ ·00005	+ ·00006	+ ·00007	+ ·00019	+ ·00013	+ ·00031	− ·00001	+ ·00003	+ ·00005	+ ·00003	+ ·00017	+ ·00010
9 ...	+ ·00027	+ ·00016	+ ·00008	+ ·00012	+ ·00011	+ ·00020	+ ·00016	+ ·00026	− ·00002	+ ·00003	+ ·00012	+ ·00004	+ ·00016	+ ·00010
10 ...	+ ·00022	+ ·00017	+ ·00003	+ ·00007	+ ·00006	+ ·00018	+ ·00013	+ ·00024	− ·00003	·00000	+ ·00002	− ·00001	+ ·00013	+ ·00006
11 ...	+ ·00010	+ ·00011	+ ·00004	·00000	+ ·00001	+ ·00011	+ ·00006	+ ·00013	+ ·00008	+ ·00001	+ ·00009	+ ·00004	+ ·00012	+ ·00008
12 ...	− ·00004	+ ·00013	+ ·00003	− ·00003	+ ·00002	+ ·00002	+ ·00002	+ ·00007	− ·00001	− ·00004	+ ·00010	+ ·00001	+ ·00006	+ ·00003
13 ...	− ·00009	·00009	− ·00001	− ·00001	− ·00004	− ·00002	− ·00002	+ ·00009	+ ·00006	− ·00002	+ ·00010	+ ·00002	+ ·00010	+ ·00006
14 ...	− ·00023	− ·00015	− ·00006	− ·00011	− ·00014	− ·00013	− ·00013	− ·00001	+ ·00007	+ ·00001	+ ·00003	+ ·00002	+ ·00004	+ ·00003
15 ...	− ·00027	− ·00013	− ·00006	− ·00009	− ·00011	− ·00016	− ·00013	− ·00011	+ ·00008	+ ·00001	+ ·00002	+ ·00002	− ·00003	− ·00001
16 ...	− ·00020	− ·00011	− ·00006	− ·00005	− ·00008	− ·00013	− ·00010	− ·00004	+ ·00005	+ ·00002	+ ·00003	+ ·00004	·00000	+ ·00002
17 ...	− ·00013	− ·00006	− ·00007	·00000	− ·00007	− ·00007	− ·00006	− ·00009	+ ·00002	− ·00002	·00000	+ ·00002	− ·00006	− ·00002
18 ...	− ·00013	− ·00011	− ·00003	− ·00001	− ·00005	− ·00009	− ·00007	− ·00003	+ ·00007	+ ·00002	− ·00002	+ ·00002	·00000	+ ·00001
19 ...	− ·00004	− ·00017	− ·00001	+ ·00005	− ·00001	− ·00008	− ·00004	− ·00006	+ ·00012	+ ·00005	− ·00001	+ ·00005	− ·00002	+ ·00001
20 ...	·00000	− ·00007	+ ·00001	+ ·00006	+ ·00003	− ·00003	+ ·00001	− ·00003	+ ·00006	+ ·00005	− ·00005	+ ·00002	·00000	+ ·00001
21 ...	− ·00003	− ·00003	− ·00001	+ ·00001	− ·00001	− ·00002	− ·00001	+ ·00001	+ ·00006	+ ·00001	− ·00002	+ ·00001	+ ·00002	+ ·00001
22 ...	+ ·00004	− ·00004	− ·00002	+ ·00005	− ·00002	+ ·00003	+ ·00001	− ·00002	+ ·00002	·00000	+ ·00002	·00000	+ ·00002	+ ·00001
23 ...	+ ·00002	+ ·00002	− ·00003	+ ·00008	·00000	+ ·00003	+ ·00002	− ·00009	− ·00002	+ ·00001	+ ·00001	− ·00002	− ·00002	− ·00002
Number of lunar days' observations in abstract ...	443	421	468	451	913	870	1783	470	451	478	474	950	923	1873

Table 119.

Declination of Moon.	North.							Changing from North to South.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0 ...	+ ·00004	+ ·00006	− ·00002	·00007	− ·00001	+ ·00005	+ ·00002	− ·00007	− ·00008	·00000	− ·00005	− ·00003	− ·00008	− ·00005
1 ...	+ ·00004	·00000	− ·00012	·00000	− ·00006	+ ·00002	− ·00002	− ·00010	− ·00007	+ ·00002	− ·00005	− ·00001	− ·00009	− ·00005
2 ...	− ·00005	− ·00003	− ·00012	− ·00006	− ·00009	− ·00004	− ·00007	− ·00021	− ·00007	− ·00001	− ·00012	− ·00005	− ·00016	− ·00010
3 ...	− ·00007	− ·00002	− ·00016	− ·00020	− ·00017	− ·00006	− ·00011	− ·00028	− ·00009	− ·00004	− ·00013	− ·00009	− ·00019	− ·00014
4 ...	− ·00001	− ·00006	− ·00013	− ·00017	− ·00014	− ·00004	− ·00009	− ·00023	− ·00006	− ·00003	− ·00011	− ·00007	− ·00015	− ·00011
5 ...	+ ·00004	− ·00003	− ·00007	− ·00004	− ·00009	+ ·00001	− ·00003	− ·00008	− ·00004	− ·00003	− ·00007	− ·00004	− ·00008	− ·00006
6 ...	+ ·00012	+ ·00001	− ·00006	− ·00008	− ·00007	+ ·00007	·00000	+ ·00009	+ ·00004	+ ·00001	− ·00012	− ·00002	+ ·00003	·00000
7 ...	+ ·00017	+ ·00003	·00000	+ ·00008	+ ·00001	+ ·00012	+ ·00006	+ ·00022	+ ·00015	+ ·00002	− ·00013	− ·00004	+ ·00015	+ ·00005
8 ...	+ ·00024	·00000	·00000	+ ·00009	+ ·00003	+ ·00013	+ ·00008	+ ·00028	+ ·00018	− ·00003	− ·00003	− ·00001	+ ·00019	+ ·00009
9 ...	+ ·00028	+ ·00003	− ·00005	+ ·00016	+ ·00002	+ ·00015	+ ·00009	+ ·00026	+ ·00013	+ ·00001	+ ·00005	+ ·00003	+ ·00018	+ ·00010
10 ...	+ ·00024	+ ·00006	− ·00007	+ ·00004	− ·00002	+ ·00015	+ ·00006	+ ·00020	+ ·00012	+ ·00004	+ ·00004	+ ·00004	+ ·00014	+ ·00009
11 ...	+ ·00010	+ ·00002	− ·00001	+ ·00006	+ ·00001	+ ·00007	+ ·00004	+ ·00014	+ ·00013	− ·00001	+ ·00001	− ·00001	+ ·00012	+ ·00005
12 ...	− ·00001	− ·00002	+ ·00001	+ ·00006	+ ·00003	− ·00001	+ ·00001	+ ·00008	+ ·00012	+ ·00001	+ ·00002	+ ·00003	+ ·00006	+ ·00004
13 ...	− ·00008	− ·00010	− ·00001	+ ·00010	·00000	− ·00005	− ·00002	+ ·00008	+ ·00004	+ ·00002	+ ·00003	·00000	+ ·00006	+ ·00003
14 ...	− ·00019	− ·00012	− ·00002	+ ·00003	+ ·00001	− ·00016	− ·00007	− ·00004	− ·00006	− ·00007	+ ·00005	− ·00005	− ·00002	− ·00004
15 ...	− ·00026	− ·00015	− ·00004	·00000	− ·00003	− ·00019	− ·00011	− ·00008	− ·00011	− ·00005	+ ·00007	− ·00004	− ·00006	− ·00005
16 ...	− ·00021	− ·00016	+ ·00007	·00000	+ ·00004	− ·00019	− ·00007	− ·00002	− ·00002	− ·00003	+ ·00005	− ·00001	− ·00003	− ·00001
17 ...	− ·00010	− ·00002	+ ·00005	·00000	+ ·00005	− ·00009	− ·00002	− ·00006	− ·00004	− ·00010	+ ·00012	− ·00002	− ·00003	− ·00003
18 ...	− ·00011	+ ·00003	+ ·00008	− ·00003	+ ·00006	− ·00008	+ ·00001	− ·00001	− ·00006	− ·00002	+ ·00011	·00000	− ·00001	·00000
19 ...	− ·00009	·00000	+ ·00013	·00000	+ ·00010	− ·00008	+ ·00001	− ·00005	− ·00012	+ ·00002	+ ·00006	+ ·00003	− ·00008	− ·00003
20 ...	− ·00002	+ ·00007	+ ·00012	− ·00005	+ ·00007	− ·00001	+ ·00003	·00000	− ·00008	+ ·00007	+ ·00005	+ ·00003	− ·00003	·00000
21 ...	− ·00002	+ ·00016	+ ·00015	+ ·00003	+ ·00013	+ ·00002	+ ·00008	− ·00001	+ ·00002	+ ·00015	+ ·00014	+ ·00012	+ ·00002	+ ·00007
22 ...	·00000	+ ·00014	+ ·00012	+ ·00002	+ ·00010	+ ·00004	+ ·00007	− ·00001	+ ·00002	+ ·00011	+ ·00007	+ ·00007	+ ·00001	+ ·00004
23 ...	+ ·00005	+ ·00018	+ ·00010	+ ·00004	+ ·00009	+ ·00009	+ ·00009	− ·00004	+ ·00002	+ ·00006	+ ·00004	+ ·00004	− ·00001	+ ·00001
Number of lunar days' observations in abstract ...	426	415	443	432	869	847	1716	482	454	511	495	1005	937	1942

Table 120.

Declination of Moon.	South.							Changing from South to North.						
Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0 ...	−·00011	−·00010	+·00001	−·00003	·00000	−·00012	+·00006	+·00006	−·00004	−·00006	−·00004	−·00004	−·00001	−·00003
1 ...	−·00020	−·00010	−·00001	+·00002	·00000	−·00016	+·00008	+·00007	−·00007	−·00006	−·00001	−·00007	+·00003	−·00002
2 ...	−·00028	−·00007	+·00002	−·00002	+·00004	−·00022	−·00010	+·00004	−·00010	−·00007	−·00009	−·00009	−·00003	−·00006
3 ...	−·00024	−·00003	+·00003	·00000	+·00005	−·00018	−·00007	−·00004	−·00010	+·00004	−·00007	−·00002	−·00006	−·00004
4 ...	−·00009	−·00008	+·00004	−·00001	+·00004	−·00012	−·00004	+·00001	−·00016	+·00002	−·00003	−·00002	−·00006	−·00004
5 ...	−·00002	−·00009	+·00006	−·00003	+·00003	−·00007	−·00003	+·00001	−·00010	+·00005	+·00002	+·00003	−·00004	−·00001
6 ...	−·00004	+·00007	+·00003	−·00006	+·00003	−·00004	−·00001	−·00001	−·00011	−·00002	·00000	−·00003	−·00004	−·00004
7 ...	·00000	+·00001	+·00002	−·00001	+·00003	−·00002	·00000	−·00000	−·00005	−·00002	+·00002	−·00001	−·00003	−·00002
8 ...	+·00004	+·00002	+·00002	·00000	·00000	+·00004	+·00001	+·00006	·00000	+·00003	+·00007	+·00003	+·00004	+·00004
9 ...	+·00009	+·00004	+·00008	+·00005	+·00005	+·00008	+·00006	+·00006	·00000	+·00003	+·00016	+·00007	+·00004	+·00006
10 ...	+·00010	+·00004	+·00006	+·00001	+·00004	+·00006	+·00004	+·00008	+·00003	−·00001	+·00007	·00000	+·00007	+·00004
11 ...	+·00007	+·00007	+·00008	−·00002	+·00004	+·00005	+·00004	+·00007	+·00001	+·00001	+·00005	+·00001	+·00004	+·00003
12 ...	+·00004	+·00001	+·00001	−·00005	−·00004	+·00004	−·00001	−·00004	+·00007	−·00002	+·00010	+·00003	+·00001	+·00002
13 ...	+·00001	+·00007	+·00003	−·00013	−·00005	+·00003	−·00001	−·00009	+·00003	−·00004	+·00007	−·00001	−·00002	−·00001
14 ...	−·00005	+·00007	−·00005	−·00017	−·00012	+·00001	−·00006	−·00017	−·00001	+·00002	−·00001	−·00003	−·00007	−·00005
15 ...	−·00004	+·00006	−·00005	−·00015	−·00010	·00000	−·00005	−·00025	−·00002	+·00004	−·00004	+·00001	−·00016	−·00007
16 ...	+·00004	·00000	−·00005	−·00004	−·00005	+·00002	−·00002	−·00019	−·00009	+·00005	−·00001	+·00001	−·00014	−·00006
17 ...	+·00001	−·00005	−·00009	+·00003	−·00004	−·00001	−·00003	−·00021	−·00006	+·00001	·00000	+·00001	−·00015	−·00007
18 ...	+·00004	·00000	−·00002	+·00013	+·00002	+·00004	+·00003	−·00003	+·00003	·00000	−·00004	·00000	−·00003	−·00001
19 ...	+·00009	+·00011	−·00003	+·00014	+·00005	+·00010	+·00007	+·00002	+·00007	·00000	−·00001	+·00002	+·00002	+·00001
20 ...	+·00017	+·00007	−·00002	+·00008	+·00004	+·00010	+·00007	+·00016	+·00016	+·00003	−·00003	+·00003	+·00012	+·00007
21 ...	+·00019	+·00003	−·00005	+·00011	·00000	+·00013	+·00006	+·00016	+·00021	·00000	−·00004	·00000	+·00016	+·00008
22 ...	+·00018	−·00004	−·00004	+·00015	+·00001	+·00011	+·00006	+·00016	+·00015	−·00003	+·00003	−·00001	+·00012	+·00005
23 ...	+·00012	−·00008	−·00003	+·00009	−·00001	+·00005	+·00002	+·00011	+·00009	−·00002	−·00005	−·00003	+·00009	+·00002
Number of lunar days' observations in abstract ...	434	412	449	432	873	854	1727	489	467	502	513	981	970	1971

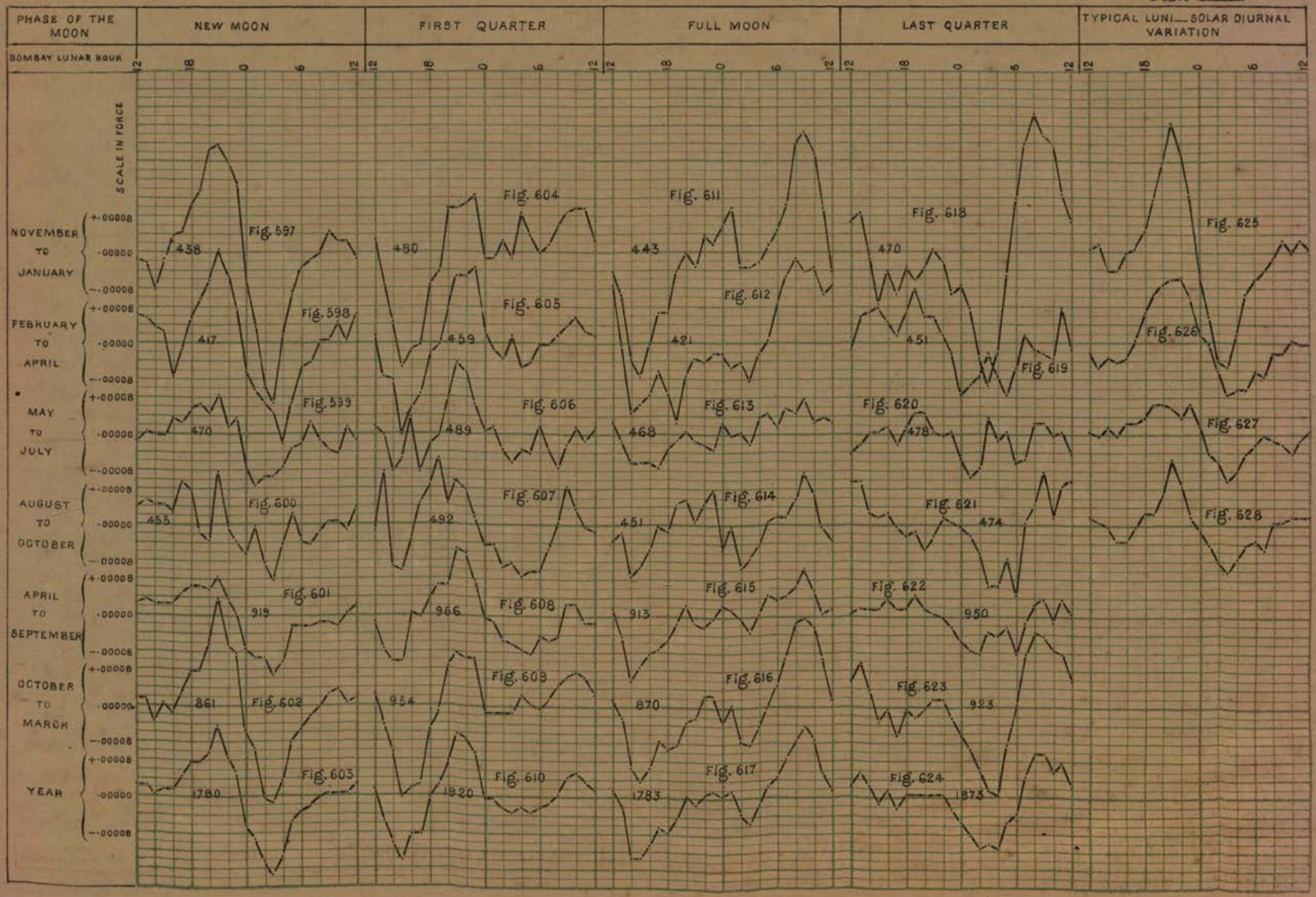
246. The curves that have been constructed to represent the variations otherwise expressed by the hourly excesses for the several quarters and phases are Figs. 597 to 624, and for the several quarters and declinations of the moon Figs. 629 to 656. The latter figures are marked with the phases to which they principally correspond.

The remarks made in paragraphs 166 and 167 on the curves representing the lunar diurnal of variations of declination apply also to the corresponding curves representing the lunar diurnal variations of horizontal force. Typical luni-solar variations were found, in the manner described in paragraph 168, from the numbers in columns 2, 5, 7 and 12 of Table 113; 3, 5, 8 and 10 of Table 114; 1, 6, 8 and 11 of Table 115; and 2, 4, 9 and 11 of Table 116. They are represented numerically in the following table and graphically by Figs. 625 to 628:—

COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF HORIZONTAL FORCE.

Plate XXX.

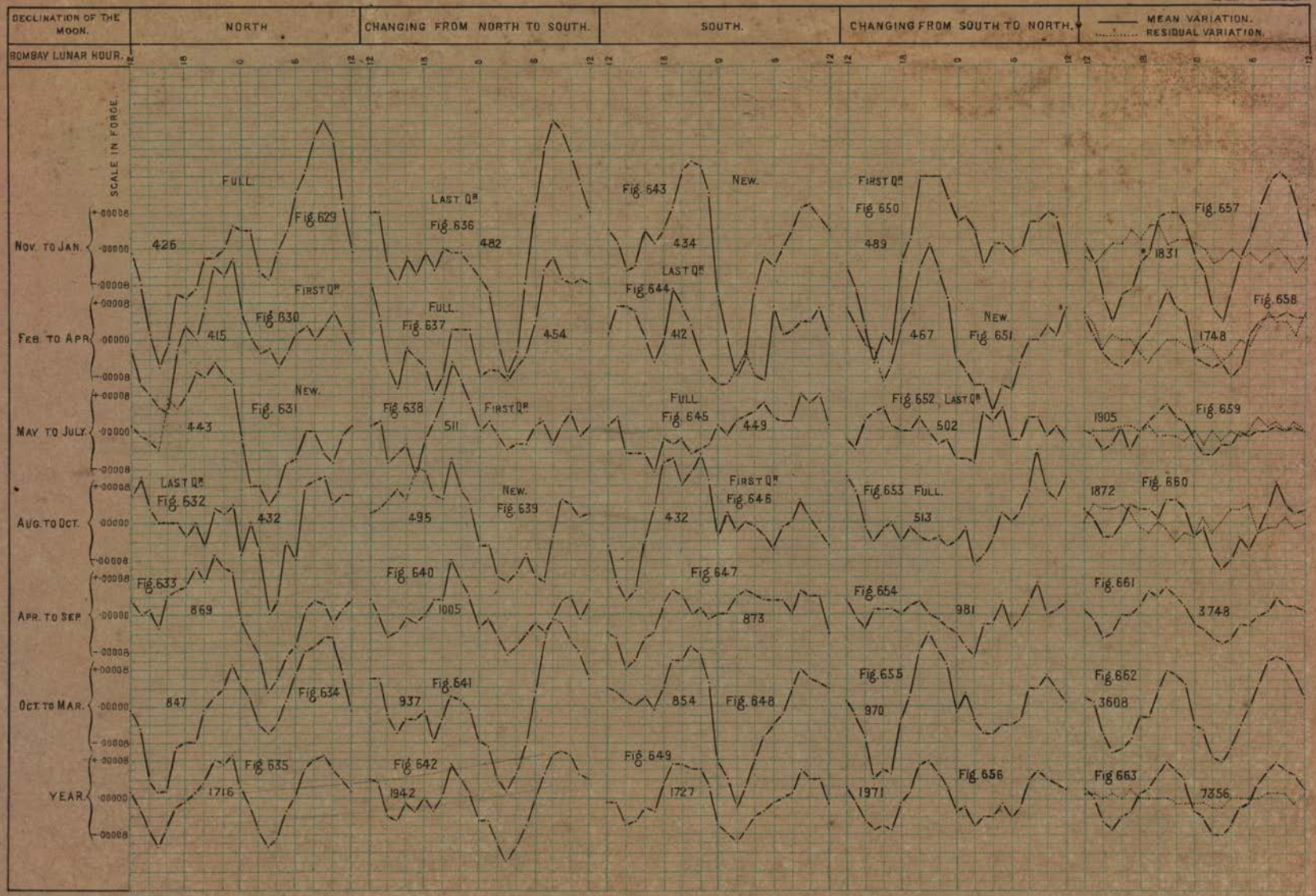


THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND

COLABA OBSERVATORY.

LUNAR DIURNAL VARIATION OF HORIZONTAL FORCE.

Plate XXXI.



THE NUMBERS WITH WHICH THE CURVES ARE MARKED REPRESENT THE NUMBER OF DAYS' OBSERVATIONS FROM WHICH THE SEVERAL VARIATIONS HAVE BEEN FOUND.

TABLE 121.

Bombay Astronomical Hours.	0	1	2	3	4	5	6	7	8	9	10	11
Nov. to Jan.	−·00005	−·00014	−·00024	−·00025	−·00018	−·00009	−·00006	−·00004	−·00001	+·00003	·00000	+·00003
Feb. to April.	+·00002	·00000	−·00006	−·00011	−·00010	−·00010	−·00006	−·00007	−·00002	−·00002	+·00001	·00000
May. to July.	+·00002	−·00004	−·00006	−·00010	−·00008	−·00004	−·00002	·00000	−·00001	−·00002	−·00004	−·00001
Aug. to Oct.	−·00001	−·00004	−·00008	−·00010	−·00007	−·00004	−·00003	−·00005	+·00001	+·00001	+·00002	+·00002

Bombay Astronomical Hours,	12	13	14	15	16	17	18	19	20	21	22	23
Nov. to Jan.	+·00001	+·00002	−·00004	−·00004	·00000	+·00001	+·00005	+·00012	+·00020	+·00029	+·00022	+·00013
Feb. to April.	·00000	−·00005	−·00003	+·00004	−·00003	+·00001	+·00007	+·00011	+·00013	+·00014	+·00014	+·00010
May to July.	+·00001	·00000	+·00002	·00000	+·00003	+·00003	+·00004	+·00007	+·00007	+·00006	+·00004	+·00007
Aug. to Oct.	+·00002	+·00001	·00000	−·00003	−·00003	·00000	+·00003	+·00003	+·00007	+·00015	+·00009	+·00002

247. Residual lunar variations were now calculated, as in paragraph 169, giving the numbers entered in Table 122 and curved, in dotted lines, in Figs. 657 to 660 and 663.

TABLE 122.

Bombay Astronomical Hours.	0	1	2	3	4	5	6	7	8	9	10	11
Nov. to Jan.	+·00001	·00000	−·00003	−·00002	·00000	−·00002	−·00001	−·00003	−·00001	·00000	−·00002	−·00005
Feb. to April.	−·00002	−·00001	−·00002	−·00005	−·00003	·00000	−·00001	+·00003	+·00006	+·00004	+·00004	+·00001
May to July.	·00000	−·00003	·00000	−·00002	·00000	−·00001	·00000	+·00003	+·00001	+·00002	·00000	+·00001
Aug. to Oct.	−·00003	+·00001	−·00002	·00000	+·00003	+·00003	+·00004	−·00002	−·00001	−·00001	+·00001	−·00001
Year ...	−·00001	−·00001	−·00002	−·00002	·00000	·00000	·00000	·00000	+·00001	+·00001	+·00001	−·00001

Bombay Astronomical Hours.	12	13	14	15	16	17	18	19	20	21	22	23
Nov. to Jan.	−·00002	−·00003	−·00001	+·00001	+·00001	+·00004	+·00002	+·00005	+·00005	+·00001	+·00002	+·00002
Feb. to April.	+·00006	+·00003	−·00002	+·00001	·00000	·00000	−·00003	−·00005	−·00002	·00000	·00000	−·00001
May to July.	·00000	·00000	·00000	·00000	·00000	+·00001	·00000	+·00001	−·00001	−·00001	−·00001	−·00002
Aug. to Oct.	·00000	+·00004	+·00003	+·00003	·00000	+·00002	−·00001	−·00002	·00000	−·00001	−·00004	−·00002
Year ...	+·00001	+·00001	·00000	+·00001	·00000	+·00002	·00000	·00000	·00000	·00000	−·00001	−·00001

248. The residual variations have little left of a systematic character, and the range of that little is small as compared with the mean lunar diurnal variations of the several quarters. And hence it appears that the same hypothesis as to the moon's effect on the solar diurnal variation that was stated in paragraph 167 with respect to the declination, would account also for the bulk of the observed phenomena when applied to the lunar diurnal variations of the horizontal force. The typical luni-solar diurnal variation of horizontal force has, it will be seen from Figs. 625 to 628, the same character all the year round, though the range of it is largest in the winter quarter and least in the summer quarter. It has a maximum about three hours before noon, a minimum about three hours after noon, and is nearly *nil* for four hours before and after midnight.

249. The typical luni-solar diurnal variation of declination (Figs. 346 to 349) is, unlike that of horizontal force, completely reversed between winter and summer: the two curves have a principal inflexion with a turning point about noon, two equal and opposite inflexions with turning points about five hours before and after noon, and little or no departure from the mean line for three or four hours before and after midnight. In changing from the winter to the summer character the variation is, in spring, almost obliterated, but the spring curve retains more of the winter than of the summer character; whilst, on the other hand, in the passage from the summer to the winter character, the autumn curve retains more of the character of the summer curve and it is, indeed, little less in range than the latter. The turning points of the three principal inflexions occur about an hour earlier in summer than in winter, and about an hour earlier in the autumn than in summer. The ranges of the winter curves are—of declination ·00031, and of horizontal force ·00054 unit of force.

249*a*. Although no separate investigation has been made using solar instead of lunar days, as in paragraphs 169*a* and 169*b*, yet we may presume that, as with the declination so with the horizontal force the period of the luni-solar variation is really the lunar day, and that the morning excursion enlarges as the age of the moon increases, whilst the afternoon excursion contracts and dies out, and a new movement is initiated in the same direction as that of the one that disappears, but about twelve hours earlier in phase. The nature of the luni-solar variations that we have found requires that these changes should completely reverse the character of the variation, and at the same time cause its phases to slip backward by about six lunar hours in every seven or eight days. Let us now consider, looking at Fig. 625 (say), what the half-way stage of these changes will be, that is to say what the curve will have become about four days after new moon: the maximum of 9 hours will have become somewhat enlarged, the minimum of 15 hours will have diminished to about half its former magnitude, and the new minimum at 3 hours will be about half-grown. These changes produce, however, a curve of the same type as the luni-solar variation of declination (Fig. 346, say) but with corresponding phases occurring about three hours earlier. We are disposed, then, to think that if, in our investigation, the lunation had been divided into eight parts instead of four only, we should have found, for the ages of the moon intermediate between the four quarters, luni-solar variations similar in character to those that we have found for the magnetic declination but generally three hours different in phase: and, conversely, we think that the luni-solar variations of declination for the parts of lunations intermediate between the quarters would have been similar to the luni-solar variations of the horizontal force for the exact quarters of the moon. Indeed, we have distinct evidence of this in the particular case of the month of January, represented by the curves of Figs. 384*gg* to 384*jjj*: for whilst the curves of the 28th to 0th, 5th to 8th, 13th to 15th and 22nd days of the moon's age are of the declination type, as we have found it, those of the 1st to 4th, 9th and 10th, 16th to 21st and 23rd to 27th approach more nearly to the horizontal force type, and the 11th and 12th are indefinite.

250. The lunar diurnal variations for each quarter, for the summer and winter half-years, and for the full year, irrespective of phase or declination of the moon, are shown in Table 123 and by curves in Figs. 657 to 663. Also the mean lunar diurnal variation for each year separately is numerically shown in Table 124.

TABLE 123.

Bombay Lunar Hour.	November to January.	February to April.	May to July.	August to October.	April to September.	October to March.	Year.
0	−·00002	−·00004	−·00002	−·00003	−·00002	−·00004	−·00003
1	−·00005	−·00005	−·00005	−·00001	−·00003	−·00005	−·00004
2	−·00013	−·00006	−·00005	−·00007	−·00005	−·00011	−·00008
3	−·00016	−·00005	−·00003	−·00010	−·00006	−·00012	−·00008
4	−·00009	−·00008	−·00003	−·00008	−·00005	−·00009	−·00006
5	−·00002	−·00006	·00000	−·00003	−·00002	−·00004	−·00002
6	+·00003	+·00001	−·00001	−·00006	−·00002	·00000	−·00001
7	+·00009	+·00004	·00000	−·00002	·00000	+·00005	+·00003
8	+·00015	+·00005	·00000	+·00003	+·00001	+·00010	+·00006
9	+·00017	+·00005	+·00001	+·00009	+·00004	+·00011	+·00008
10	+·00015	+·00006	·00000	+·00004	+·00002	+·00010	+·00006
11	+·00009	+·00005	+·00001	+·00002	+·00002	+·00007	+·00005
12	+·00001	+·00005	·00000	+·00003	+·00001	+·00002	+·00002
13	−·00003	+·00001	−·00001	+·00001	−·00001	+·00001	·00000
14	−·00011	−·00003	−·00004	−·00003	−·00005	−·00006	−·00005
15	−·00016	−·00005	−·00003	−·00003	−·00004	−·00010	−·00007
16	−·00010	−·00006	+·00001	·00000	·00000	−·00009	−·00004
17	−·00009	−·00004	−·00004	+·00004	·00000	−·00007	−·00003
18	−·00003	·00000	·00000	+·00003	+·00002	−·00002	+·00001
19	−·00001	+·00002	+·00002	+·00003	+·00005	−·00002	+·00002
20	+·00007	+·00006	+·00004	+·00001	+·00004	+·00004	+·00005
21	+·00008	+·00011	+·00006	+·00005	+·00006	+·00008	+·00008
22	+·00008	+·00007	+·00003	+·00005	+·00004	+·00007	+·00006
23	+·00005	+·00006	+·00002	+·00003	+·00002	+·00005	+·00004
Number of lunar days' observations in abstract ...	1831	1748	1905	1872	3748	3608	7356

Table 124.

Bombay Lunar Hour.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.
0	−·00004	−·00011	−·00007	·00000	+·00007	−·00004	·00000	−·00007	+·00004	−·00006	+·00006	−·00006	·00000
1	−·00004	−·00007	·00000	·00000	−·00004	−·00007	·00000	−·00004	+·00007	−·00017	−·00011	−·00011	−·00006
2	−·00011	−·00007	−·00014	·00000	−·00011	+·00004	−·00007	−·00011	+·00007	−·00017	−·00017	−·00017	−·00017
3	−·00011	−·00004	−·00011	·00000	−·00011	·00000	−·00015	−·00007	+·00004	−·00011	−·00006	−·00006	−·00017
4	−·00007	−·00004	−·00007	·00000	−·00011	+·00007	−·00007	−·00004	·00000	−·00011	·00000	·00000	−·00017
5	−·00018	−·00004	+·00007	+·00004	−·00004	+·00004	−·00004	−·00004	+·00004	−·00006	·00000	·00000	−·00017
6	−·00007	·00000	+·00011	·00000	−·00007	−·00007	·00000	·00000	+·00007	·00000	+·00011	+·00006	−·00006
7	−·00004	+·00004	+·00018	−·00007	−·00004	+·00004	+·00004	·00000	+·00004	·00000	+·00011	+·00006	·00000
8	·00000	+·00004	+·00022	·00000	+·00004	+·00004	+·00004	+·00011	+·00015	+·00006	+·00017	+·00011	+·00006
9	+·00007	+·00007	+·00022	−·00004	+·00007	+·00004	+·00018	+·00007	+·00011	+·00011	+·00017	+·00011	+·00006
10	+·00004	+·00004	+·00022	−·00004	·00000	·00000	+·00011	+·00011	+·00007	+·00011	+·00017	+·00006	+·00006
11	+·00004	−·00004	+·00011	−·00004	+·00004	·00000	+·00011	+·00011	+·00004	+·00006	+·00006	+·00011	+·00006
12	·00000	−·00007	+·00007	−·00004	·00000	·00000	+·00004	+·00004	+·00004	+·00011	+·00006	+·00011	·00000
13	−·00004	·00000	+·00004	·00000	−·00011	·00000	−·00004	·00000	−·00004	·00000	·00000	+·00017	+·00011
14	·00000	−·00004	−·00007	−·00007	−·00004	+·00007	−·00007	−·00007	−·00004	−·00011	−·00006	+·00006	+·00006
15	·00000	+·00004	−·00014	−·00004	−·00011	·00000	−·00011	−·00011	·00000	·00000	−·00006	·00000	·00000
16	+·00004	+·00011	−·00014	+·00004	−·00004	·00000	−·00018	−·00004	·00000	−·00006	−·00006	·00000	−·00006
17	·00000	+·00007	−·00007	−·00004	−·00004	·00000	−·00014	−·00007	−·00007	−·00006	−·00006	−·00006	·00000
18	+·00004	+·00007	−·00004	−·00004	·00000	·00000	−·00004	+·00007	−·00011	+·00006	−·00006	−·00006	·00000
19	+·00004	+·00007	−·00007	·00000	+·00011	−·00004	+·00004	·00000	−·00015	+·00006	−·00006	·00000	+·00006
20	+·00007	+·00007	·00000	+·00007	+·00011	+·00004	+·00004	·00000	−·00007	+·00011	+·00006	·00000	−·00006
21	+·00011	+·00004	·00000	+·00007	+·00011	−·00004	+·00004	+·00007	−·00004	+·00011	+·00006	·00000	+·00006
22	+·00007	·00000	−·00007	+·00007	+·00014	+·00011	+·00004	+·00007	−·00004	+·00006	+·00006	−·00006	·00000
23	+·00004	+·00011	−·00011	+·00011	+·00011	+·00004	+·00007	·00000	−·00004	·00000	+·00011	−·00006	·00000
Number of lunar days' observations in abstract.	273	269	291	294	274	289	277	290	291	293	282	275	257

TABLE 124—*continued.*

Bombay Lunar Hour.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.
0	−·00006	−·00017	·00000	·00000	+·00006	·00000	·00000	−·00006	−·00006	·00000	−·00006	−·00006	−·00016
1	−·00006	−·00006	−·00006	−·00006	·00000	·00000	−·00006	·00000	−·00006	+·00006	·00000	−·00011	·00000
2	−·00017	−·00011	·00000	+·00006	−·00017	−·00006	−·00011	−·00006	−·00006	−·00006	·00000	·00000	−·00022
3	−·00017	−·00011	−·00006	−·00011	−·00017	−·00011	−·00017	−·00006	−·00011	−·00011	+·00011	−·00011	−·00011
4	−·00017	−·00011	−·00006	·00000	−·00011	−·00011	−·00011	−·00011	−·00011	−·00016	−·00006	−·00011	·00000
5	−·00011	−·00011	+·00006	·00000	−·00011	·00000	−·00006	−·00006	−·00006	−·00006	·00000	−·00006	−·00016
6	−·00011	−·00006	+·00011	·00000	−·00011	−·00006	−·00006	−·00006	−·00006	−·00006	+·00006	·00000	−·00011
7	·00000	+·00011	+·00006	+·00011	·00000	−·00006	·00000	+·00006	·00000	−·00011	+·00011	+·00006	−·00011
8	+·00006	+·00011	+·00006	+·00006	−·00006	−·00006	+·00006	+·00011	−·00011	−·00006	+·00011	+·00006	·00000
9	+·00006	+·00022	+·00011	+·00006	+·00006	−·00006	+·00006	+·00006	·00000	−·00006	−·00006	·00000	+·00011
10	+·00006	+·00028	+·00011	+·00006	−·00011	·00000	+·00011	·00000	+·00011	·00000	·00000	·00000	+·00011
11	·00000	+·00017	+·00006	·00000	−·00011	·00000	+·00017	−·00006	+·00011	·00000	−·00006	·00000	+·00016
12	·00000	+·00017	−·00006	−·00006	−·00006	+·00006	+·00006	·00000	+·00017	−·00011	−·00011	+·00006	+·00016
13	−·00006	+·00017	·00000	·00000	−·00006	·00000	·00000	−·00006	+·00006	·00000	−·00006	·00000	+·00011
14	−·00011	+·00006	−·00006	−·00006	−·00006	−·00006	−·00006	−·00006	·00000	−·00006	−·00011	−·00011	−·00006
15	−·00017	−·00011	−·00017	−·00006	−·00006	·00000	·00000	−·00006	−·00011	−·00016	−·00022	−·00011	−·00006
16	·00000	−·00011	−·00006	·00000	−·00006	·00000	·00000	−·00006	−·00006	−·00011	−·00016	−·00006	+·00011
17	·00000	−·00017	−·00006	−·00006	·00000	+·00006	−·00006	+·00006	−·00006	−·00006	−·00011	−·00006	+·00006
18	+·00006	−·00006	+·00006	·00000	−·00006	+·00006	+·00006	+·00006	·00000	·00000	+·00006	−·00006	+·00011
19	+·00011	−·00006	+·00006	+·00006	+·00006	+·00006	+·00006	+·00006	+·00006	·00000	·00000	+·00006	−·00006
20	+·00006	·00000	·00000	+·00006	+·00011	+·00011	+·00011	+·00006	−·00006	+·00016	·00000	+·00006	+·00011
21	+·00017	+·00006	+·00011	+·00006	+·00011	+·00006	+·00017	+·00011	·00000	+·00022	+·00006	+·00011	+·00011
22	+·00017	+·00006	+·00006	·00000	+·00017	+·00011	+·00006	+·00006	−·00006	+·00011	+·00011	+·00006	+·00011
23	+·00011	·00000	+·00006	·00000	+·00006	+·00011	+·00006	·00000	−·00011	+·00011	+·00011	+·00006	+·00011
Number of lunar days' observations in abstract.	258	274	276	287	284	279	285	289	255	271	259	268	266

APPENDIX IV.

The Solar diurnal variations of Declination, Horizontal Force, and Vertical Force at Bombay, as derived from the registrations of the Cola'ba Magnetographs.

251. The data used for this investigation are the entries on the monthly abstracts described in Appendix I. paragraph 17—of declination from January 1871 to April 1882, of horizontal force from January 1872 to April 1880, and of vertical force from May 1872 to April 1879. The variations were taken of the mean hourly tabulations at the foot of each abstract, and these were then converted into force by means of the co-efficients of Table 21* (paragraph 67), Tables 34 and 35 (paragraphs 107 and 108), and those described in paragraph 117. It is these converted variations, and averages of groups of them, that are entered in Tables 125 to 156 and curved on Plates XXXII to XXXVI.

TABLE 125.—DECLINATION MAGNETOGRAPH.

Showing the mean diurnal variation of Declination for each month of the year 1871 *and for the whole year.*

1871. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00096	+ ·00109	+ ·00127	+ ·00009	− ·00090	− ·00022	− ·00062	− ·00103	− ·00037	− ·00065	+ ·00016	+ ·00009	− ·00003
11 18 ...	− ·00031	+ ·00050	− ·00040	− ·00208	− ·00211	− ·00208	− ·00208	− ·00255	− ·00242	− ·00171	− ·00056	− ·00012	− ·00133
12 18 ...	− ·00059	+ ·00003	− ·00137	− ·00298	− ·00280	− ·00304	− ·00277	− ·00342	− ·00342	− ·00202	− ·00050	− ·00012	− ·00192
13 18 ...	− ·00031	+ ·00006	− ·00146	− ·00280	− ·00242	− ·00323	− ·00277	− ·00348	− ·00314	− ·00134	− ·00012	+ ·00019	− ·00173
14 18 ...	− ·00034	− ·00022	− ·00090	− ·00227	− ·00171	− ·00245	− ·00211	− ·00242	− ·00193	− ·00053	+ ·00006	+ ·00047	− ·00120
15 18 ...	+ ·00025	− ·00006	− ·00006	− ·00099	− ·00059	− ·00146	− ·00103	− ·00096	− ·00053	+ ·00031	+ ·00009	+ ·00050	− ·00038
16 18 ...	+ ·00047	− ·00009	− ·00006	− ·00025	+ ·00025	− ·00047	− ·00009	+ ·00025	+ ·00031	+ ·00040	− ·00006	+ ·00040	+ ·00009
17 18 ...	− ·00009	− ·00050	− ·00062	− ·00006	+ ·00043	+ ·00028	+ ·00034	+ ·00068	+ ·00025	− ·00040	− ·00053	− ·00003	− ·00002
18 18 ...	− ·00034	− ·00078	− ·00093	− ·00022	+ ·00009	+ ·00043	+ ·00016	+ ·00037	− ·00019	− ·00053	− ·00025	+ ·00006	− ·00018
19 18 ...	+ ·00009	− ·00019	− ·00053	− ·00031	− ·00050	− ·00034	− ·00053	− ·00016	− ·00022	− ·00012	+ ·00016	+ ·00037	− ·00019
20 18 ...	+ ·00012	− ·00009	− ·00043	− ·00019	− ·00053	− ·00053	− ·00062	− ·00034	− ·00009	+ ·00003	+ ·00012	+ ·00028	− ·00019
21 18 ...	+ ·00006	− ·00009	− ·00019	− ·00009	− ·00037	− ·00040	− ·00053	− ·00037	− ·00022	+ ·00003	+ ·00022	+ ·00034	− ·00013
22 18 ..	+ ·00006	+ ·00006	− ·00012	+ ·00012	− ·00022	− ·00025	− ·00043	− ·00028	− ·00016	+ ·00019	+ ·00037	+ ·00034	− ·00003
23 18 ...	+ ·00019	+ ·00019	− ·00003	+ ·00034	− ·00006	+ ·00003	− ·00031	− ·00009	+ ·00009	+ ·00047	+ ·00065	+ ·00043	+ ·00017
0 18 ...	+ ·00037	+ ·00043	+ ·00003	+ ·00056	+ ·00012	+ ·00022	·00000	+ ·00003	+ ·00034	+ ·00047	+ ·00078	+ ·00040	+ ·00031
1 18 ...	+ ·00031	+ ·00037	+ ·00009	+ ·00065	+ ·00025	+ ·00034	+ ·00009	+ ·00019	+ ·00040	+ ·00050	+ ·00062	+ ·00034	+ ·00035
2 18 ..	+ ·00016	+ ·00043	+ ·00003	+ ·00053	+ ·00022	+ ·00037	+ ·00012	+ ·00022	+ ·00037	+ ·00031	+ ·00047	+ ·00006	+ ·00027
3 18 ...	− ·00006	+ ·00003	− ·00016	+ ·00050	+ ·00028	+ ·00031	+ ·00034	+ ·00031	+ ·00034	+ ·00019	+ ·00009	− ·00016	+ ·00017
4 18 ...	− ·00037	− ·00025	− ·00019	+ ·00040	+ ·00040	+ ·00047	+ ·00056	+ ·00068	+ ·00031	+ ·00006	− ·00012	− ·00034	+ ·00013
5 18 ...	− ·00053	− ·00056	− ·00009	+ ·00059	+ ·00102	+ ·00112	+ ·00134	+ ·00124	+ ·00056	·00000	− ·00056	− ·00062	+ ·00029
6 18 ...	− ·00075	− ·00087	+ ·00022	+ ·00183	+ ·00252	+ ·00298	+ ·00304	+ ·00304	+ ·00186	+ ·00068	− ·00096	− ·00084	+ ·00106
7 18 ...	− ·00096	− ·00078	+ ·00137	+ ·00283	+ ·00320	+ ·00354	+ ·00354	+ ·00385	+ ·00320	+ ·00155	− ·00071	− ·00130	+ ·00161
8 18 ...	+ ·00019	+ ·00012	+ ·00199	+ ·00261	+ ·00248	+ ·00311	+ ·00295	+ ·00308	+ ·00292	+ ·00149	+ ·00006	− ·00084	+ ·00168
9 18 ...	+ ·00143	+ ·00093	+ ·00221	+ ·00140	+ ·00075	+ ·00152	+ ·00146	+ ·00093	+ ·00146	+ ·00062	+ ·00053	− ·00006	+ ·00110

* For the period (February 8th to 16th, 1879) entered in this table as having a variable coefficient, the two last days were rejected, and the mean coefficient adopted for the remaining days was ·0483.

TABLE 126.—DECLINATION MAGNETOGRAPH.

Showing the mean diurnal variation of Declination for each month of the year 1872 *and for the whole year.*

1872. Bombay Civil Time.	MONTH. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00143	+ ·00140	+ ·00031	+ ·00025	− ·00103	− ·00059	− ·00068	− ·00059	− ·00065	− ·00003	+ ·00022	− ·00003	·00000
11 18 ...	+ ·00090	+ ·00056	− ·00093	− ·00137	− ·00246	− ·00199	− ·00211	− ·00218	− ·00267	− ·00124	− ·00056	− ·00084	− ·00124
12 18 ...	+ ·00053	+ ·00009	− ·00168	− ·00236	− ·00323	− ·00255	− ·00270	− ·00302	− ·00370	− ·00165	− ·00022	− ·00059	− ·00176
13 18 ...	+ ·00034	− ·00003	− ·00155	− ·00239	− ·00277	− ·00236	− ·00258	− ·00295	− ·00333	− ·00103	+ ·00037	+ ·00022	− ·00150
14 18 ...	− ·00019	− ·00009	− ·00056	− ·00171	− ·00177	− ·00193	− ·00180	− ·00208	− ·00196	− ·00028	+ ·00062	+ ·00081	− ·00091
15 18 ...	− ·00037	− ·00056	+ ·00019	− ·00087	− ·00059	− ·00121	− ·00087	− ·00099	− ·00065	+ ·00025	+ ·00050	+ ·00090	− ·00036
16 18 ..	− ·00006	− ·00068	+ ·00025	− ·00022	+ ·00022	− ·00050	− ·00031	− ·00012	+ ·00003	+ ·00012	+ ·00019	+ ·00059	− ·00004
17 18 ...	− ·00016	− ·00084	− ·00019	− ·00022	+ ·00022	+ ·00006	+ ·00022	+ ·00031	·00000	− ·00056	− ·00028	− ·00022	− ·00014
18 18 ...	− ·00034	− ·00090	− ·00075	− ·00056	− ·00006	+ ·00016	+ ·00019	+ ·00012	− ·00019	− ·00034	− ·00012	− ·00003	− ·00023
19 18 ...	+ ·00009	− ·00037	− ·00034	− ·00068	− ·00059	− ·00044	− ·00044	− ·00034	− ·00022	− ·00006	+ ·00006	+ ·00012	− ·00027
20 18 ...	+ ·00006	− ·00037	− ·00031	− ·00056	− ·00044	− ·00053	− ·00056	− ·00050	+ ·00003	+ ·00003	·00000	+ ·00009	− ·00025
21 18 ...	+ ·00006	− ·00025	− ·00028	− ·00031	− ·00022	− ·00037	− ·00037	− ·00047	·00000	− ·00016	+ ·00003	+ ·00003	− ·00019
22 18 ...	+ ·00019	+ ·00056	− ·00003	+ ·00003	·00000	− ·00016	− ·00031	− ·00040	+ ·00016	·00000	+ ·00016	+ ·00009	+ ·00002
23 18 ...	+ ·00022	+ ·00037	+ ·00022	+ ·00019	+ ·00006	+ ·00009	− ·00009	− ·00028	+ ·00025	+ ·00016	+ ·00028	+ ·00022	+ ·00014
0 18 ...	+ ·00025	+ ·00059	+ ·00022	+ ·00050	+ ·00031	+ ·00022	+ ·00006	− ·00006	+ ·00044	+ ·00022	+ ·00031	+ ·00022	+ ·00027
1 18 ...	+ ·00019	+ ·00050	+ ·00025	+ ·00050	+ ·00037	+ ·00044	+ ·00034	+ ·00016	+ ·00053	+ ·00016	+ ·00025	+ ·00022	+ ·00033
2 18 ...	+ ·00003	+ ·00031	+ ·00012	+ ·00053	+ ·00053	+ ·00053	+ ·00050	+ ·00031	+ ·00047	+ ·00019	+ ·00019	+ ·00016	+ ·00032
3 18 ...	− ·00025	·00000	− ·00009	+ ·00040	+ ·00047	+ ·00059	+ ·00062	+ ·00050	+ ·00047	− ·00006	− ·00016	·00000	+ ·00021
4 18 ...	− ·00050	− ·00044	− ·00022	+ ·00022	+ ·00059	+ ·00062	+ ·00068	+ ·00050	+ ·00040	− ·00022	− ·00053	− ·00022	+ ·00007
5 18 ...	− ·00081	− ·00068	− ·00028	+ ·00044	+ ·00121	+ ·00106	+ ·00121	+ ·00109	+ ·00056	− ·00019	− ·00078	− ·00047	+ ·00020
6 18 ...	− ·00096	− ·00078	+ ·00037	+ ·00165	+ ·00280	+ ·00258	+ ·00258	+ ·00274	+ ·00208	+ ·00037	− ·00093	− ·00059	+ ·00099
7 18 ...	− ·00140	− ·00050	+ ·00149	+ ·00277	+ ·00326	+ ·00295	+ ·00308	+ ·00367	+ ·00336	+ ·00152	− ·00065	− ·00072	+ ·00157
8 18 ...	− ·00047	+ ·00050	+ ·00211	+ ·00261	+ ·00264	+ ·00246	+ ·00246	+ ·00302	+ ·00302	+ ·00165	+ ·00031	− ·00019	+ ·00168
9 18 ...	+ ·00106	+ ·00149	+ ·00159	+ ·00149	+ ·00081	+ ·00081	+ ·00078	+ ·00124	+ ·00140	+ ·00115	+ ·00075	+ ·00053	+ ·00109

TABLE 127.—DECLINATION MAGNETOGRAPH.

Showing the mean diurnal variation of declination for each month of the year 1873 *and for the whole year.*

1873. Bombay Civil Time.			MONTH.											Year.
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.	m.														
10	18	...	+ ·00099	+ ·00009	+ ·00087	+ ·00078	− ·00084	− ·00012	− ·00040	− ·00084	− ·00096	− ·00068	− ·00012	+ ·00016	− ·00009
11	18	...	− ·00012	− ·00062	− ·00081	− ·00109	− ·00208	− ·00118	− ·00165	− ·00215	− ·00233	− ·00140	− ·00044	− ·00031	− ·00118
12	18	...	− ·00103	− ·00078	− ·00183	− ·00208	− ·00274	− ·00190	− ·00230	− ·00289	− ·00295	− ·00140	− ·00012	− ·00040	− ·00170
13	18	...	− ·00047	− ·00028	− ·00149	− ·00221	− ·00221	− ·00180	− ·00236	− ·00274	− ·00239	− ·00081	+ ·00040	− ·00012	− ·00137
14	18	...	− ·00044	+ ·00003	− ·00056	− ·00152	− ·00155	− ·00140	− ·00183	− ·00208	− ·00109	− ·00003	+ ·00044	+ ·00016	− ·00082
15	18	...	− ·00012	+ ·00031	+ ·00012	− ·00087	− ·00075	− ·00096	− ·00118	− ·00084	+ ·00022	+ ·00062	+ ·00019	+ ·00019	− ·00026
16	18	...	+ ·00025	+ ·00025	+ ·00012	− ·00047	− ·00009	− ·00087	− ·00053	+ ·00009	+ ·00075	+ ·00053	− ·00003	+ ·00022	+ ·00002
17	18	...	+ ·00019	− ·00040	− ·00050	− ·00040	+ ·00009	− ·00037	− ·00016	+ ·00037	+ ·00034	− ·00016	− ·00009	+ ·00016	− ·00008
18	18	..	+ ·00022	− ·00059	− ·00103	− ·00075	− ·00028	− ·00037	− ·00012	+ ·00006	− ·00022	− ·00019	+ ·00012	+ ·00016	− ·00025
19	18	...	+ ·00053	− ·00012	− ·00059	− ·00078	− ·00068	− ·00068	− ·00050	− ·00034	− ·00016	+ ·00006	+ ·00025	+ ·00025	− ·00023
20	18	...	+ ·00047	− ·00006	− ·00016	− ·00053	− ·00053	− ·00075	− ·00056	− ·00037	− ·00016	− ·00003	+ ·00025	+ ·00025	− ·00018
21	18	...	+ ·00040	− ·00012	− ·00016	− ·00037	− ·00025	− ·00053	− ·00050	− ·00031	− ·00009	·00000	+ ·00031	+ ·00012	− ·00012
22	18	...	+ ·00040	+ ·00003	− ·00016	+ ·00003	− ·00003	− ·00019	− ·00028	− ·00016	− ·00006	+ ·00022	+ ·00034	+ ·00019	+ ·00003
23	18	...	+ ·00040	+ ·00012	+ ·00009	+ ·00019	+ ·00022	·00000	− ·00006	·00000	+ ·00009	+ ·00034	+ ·00040	+ ·00028	+ ·00017
0	18	...	+ ·00025	+ ·00028	+ ·00019	+ ·00034	+ ·00044	+ ·00025	+ ·00019	+ ·00009	+ ·00022	+ ·00037	+ ·00037	+ ·00022	+ ·00026
1	18	...	+ ·00022	+ ·00031	+ ·00012	+ ·00056	+ ·00068	+ ·00040	+ ·00034	+ ·00025	+ ·00019	+ ·00034	+ ·00034	+ ·00016	+ ·00033
2	18	...	+ ·00009	+ ·00034	+ ·00009	+ ·00050	+ ·00065	+ ·00053	+ ·00053	+ ·00040	+ ·00031	+ ·00034	+ ·00025	+ ·00012	+ ·00035
3	18	...	− ·00022	+ ·00019	+ ·00006	+ ·00031	+ ·00068	+ ·00050	+ ·00050	+ ·00059	+ ·00037	+ ·00022	·00000	− ·00009	+ ·00026
4	18	...	− ·00062	·00000	− ·00006	+ ·00009	+ ·00065	+ ·00050	+ ·00059	+ ·00065	+ ·00040	·00000	− ·00028	− ·00025	+ ·00014
5	18	...	− ·00078	− ·00028	− ·00009	+ ·00009	+ ·00093	+ ·00078	+ ·00112	+ ·00112	+ ·00056	− ·00009	− ·00053	− ·00044	+ ·00020
6	18	...	− ·00096	− ·00040	+ ·00019	+ ·00112	+ ·00208	+ ·00177	+ ·00233	+ ·00255	+ ·00171	+ ·00009	− ·00078	− ·00059	+ ·00076
7	18	...	− ·00068	+ ·00009	+ ·00134	+ ·00215	+ ·00261	+ ·00264	+ ·00302	+ ·00323	+ ·00274	+ ·00068	− ·00072	− ·00096	+ ·00134
8	18	...	+ ·00016	+ ·00090	+ ·00199	+ ·00267	+ ·00211	+ ·00246	+ ·00264	+ ·00258	+ ·00211	+ ·00059	− ·00025	− ·00028	+ ·00147
9	18	...	+ ·00127	+ ·00096	+ ·00196	+ ·00224	+ ·00071	+ ·00128	+ ·00124	+ ·00084	+ ·00059	+ ·00003	·00000	+ ·00047	+ ·00097

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TABLE 128.—DECLINATION MAGNETOGRAPH.

Showing the mean diurnal variation of declination for each month of the year 1874 *and for the whole year.*

1874. Bombay Civil Time.			MONTH.											Year.
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.	m.														
10	18	...	+ ·00109	+ ·00100	+ ·00112	− ·00006	− ·00028	+ ·00037	+ ·00016	− ·00056	− ·00072	− ·00022	− ·00044	+ ·00006	+ ·00013
11	18	...	+ ·00050	+ ·00078	− ·00009	− ·00137	− ·00143	− ·00093	− ·00096	− ·00184	− ·00215	− ·00112	− ·00084	− ·00034	− ·00082
12	18	...	·00000	+ ·00034	− ·00109	− ·00205	− ·00212	− ·00184	− ·00168	− ·00240	− ·00280	− ·00140	− ·00047	+ ·00022	− ·00127
13	18	...	− ·00006	+ ·00009	− ·00128	− ·00190	− ·00209	− ·00199	− ·00199	− ·00218	− ·00255	− ·00090	+ ·00006	+ ·00040	− ·00120
14	18	...	− ·00003	− ·00006	− ·00072	− ·00134	− ·00149	− ·00159	− ·00168	− ·00165	− ·00152	− ·00022	+ ·00022	+ ·00056	− ·00079
15	18	...	− ·00016	− ·00040	− ·00012	− ·00059	− ·00075	− ·00106	− ·00093	− ·00068	− ·00037	+ ·00028	+ ·00040	+ ·00056	− ·00032
16	18	...	− ·00009	− ·00047	− ·00006	− ·00003	− ·00019	− ·00056	− ·00037	+ ·00006	+ ·00031	+ ·00037	+ ·00037	+ ·00062	·00000
17	18	...	− ·00006	− ·00047	− ·00019	·00000	− ·00003	− ·00025	− ·00016	+ ·00028	+ ·00028	− ·00012	+ ·00006	+ ·00034	− ·00003
18	18	...	+ ·00003	− ·00047	− ·00034	− ·00025	− ·00012	− ·00016	− ·00012	+ ·00009	− ·00003	− ·00025	+ ·00012	+ ·00025	− ·00010
19	18	...	+ ·00025	− ·00012	− ·00031	− ·00028	− ·00044	− ·00056	− ·00062	− ·00031	− ·00006	− ·00012	+ ·00019	+ ·00016	− ·00018
20	18	...	+ ·00025	+ ·00006	− ·00019	− ·00028	− ·00034	− ·00056	− ·00062	− ·00040	− ·00003	− ·00009	+ ·00019	+ ·00003	− ·00016
21	18	...	+ ·00025	+ ·00006	− ·00006	− ·00016	− ·00022	− ·00040	− ·00047	− ·00025	− ·00003	− ·00006	+ ·00019	+ ·00003	− ·00009
22	18	...	+ ·00028	+ ·00019	·00000	+ ·00009	·00000	− ·00025	− ·00031	− ·00009	+ ·00009	·00000	+ ·00025	+ ·00003	+ ·00002
23	18	...	+ ·00028	+ ·00037	+ ·00012	+ ·00028	+ ·00016	− ·00003	·00000	+ ·00006	+ ·00025	+ ·00025	+ ·00031	+ ·00006	+ ·00018
0	18	...	+ ·00034	+ ·00050	+ ·00019	+ ·00040	+ ·00028	+ ·00025	+ ·00022	+ ·00016	+ ·00031	+ ·00022	+ ·00031	+ ·00003	+ ·00027
1	18	...	+ ·00025	+ ·00040	+ ·00016	+ ·00044	+ ·00034	+ ·00040	+ ·00031	+ ·00028	+ ·00037	+ ·00034	+ ·00022	+ ·00006	+ ·00030
2	18	...	+ ·00006	+ ·00025	+ ·00012	+ ·00037	+ ·00034	+ ·00040	+ ·00044	+ ·00031	+ ·00037	+ ·00034	+ ·00009	− ·00003	+ ·00025
3	18	...	− ·00022	− ·00003	− ·00006	+ ·00031	+ ·00034	+ ·00034	+ ·00047	+ ·00025	+ ·00034	+ ·00019	− ·00006	− ·00019	+ ·00014
4	18	...	− ·00031	− ·00028	− ·00022	+ ·00028	+ ·00034	+ ·00037	+ ·00044	+ ·00031	+ ·00031	·00000	− ·00022	− ·00040	+ ·00005
5	18	...	− ·00068	− ·00053	− ·00034	+ ·00022	+ ·00053	+ ·00062	+ ·00075	+ ·00065	+ ·00044	− ·00003	− ·00044	− ·00059	+ ·00005
6	18	...	− ·00093	− ·00072	− ·00016	+ ·00096	+ ·00162	+ ·00165	+ ·00174	+ ·00184	+ ·00165	+ ·00012	− ·00065	− ·00062	+ ·00054
7	18	...	− ·00112	− ·00078	+ ·00065	+ ·00193	+ ·00233	+ ·00215	+ ·00221	+ ·00271	+ ·00268	+ ·00081	− ·00037	− ·00081	+ ·00103
8	18	...	− ·00040	− ·00006	+ ·00137	+ ·00190	+ ·00230	+ ·00205	+ ·00209	+ ·00240	+ ·00227	+ ·00103	+ ·00009	− ·00047	+ ·00121
9	18	...	+ ·00056	+ ·00068	+ ·00165	+ ·00118	+ ·00121	+ ·00137	+ ·00143	+ ·00109	+ ·00087	+ ·00053	+ ·00012	+ ·00016	+ ·00090

Table 129.—Declination Magnetograph.

Showing the mean diurnal variation of declination for each month of the year 1875 *and for the whole year.*

1875. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00006	− ·00031	+ ·00081	+ ·00009	− ·00053	− ·00006	+ ·00019	− ·00078	− ·00081	− ·00065	− ·00037	− ·00006	− ·00020
11 18 ...	− ·00087	− ·00081	+ ·00009	− ·00087	− ·00171	− ·00109	− ·00084	− ·00177	− ·00227	− ·00128	− ·00090	− ·00016	− ·00104
12 18 ...	− ·00087	− ·00093	− ·00081	− ·00159	− ·00252	− ·00184	− ·00134	− ·00227	− ·00290	− ·00137	− ·00078	− ·00009	− ·00144
13 18 ...	− ·00025	− ·00025	− ·00112	− ·00165	− ·00224	− ·00193	− ·00153	− ·00206	− ·00218	− ·00075	− ·00009	+ ·00019	− ·00115
14 18 ...	+ ·00034	+ ·00050	− ·00062	− ·00103	− ·00156	− ·00165	− ·00137	− ·00137	− ·00100	− ·00003	+ ·00034	+ ·00034	− ·00059
15 18 ...	+ ·00090	+ ·00087	+ ·00022	− ·00028	− ·00075	− ·00097	− ·00087	− ·00050	+ ·00003	+ ·00059	+ ·00050	+ ·00031	·00000
16 18 ...	+ ·00084	+ ·00093	+ ·00040	+ ·00016	− ·00006	− ·00044	− ·00053	+ ·00019	+ ·00059	+ ·00062	+ ·00044	+ ·00031	+ ·00029
17 18 ...	+ ·00012	+ ·00031	− ·00003	+ ·00031	+ ·00025	− ·00028	− ·00047	+ ·00028	+ ·00040	+ ·00006	+ ·00022	+ ·00034	+ ·00013
18 18 ...	·00000	+ ·00003	− ·00031	− ·00009	− ·00003	− ·00031	− ·00040	− ·00025	− ·00009	− ·00006	+ ·00019	+ ·00037	− ·00008
19 18 ...	+ ·00016	+ ·00022	− ·00022	− ·00034	− ·00034	− ·00053	− ·00056	− ·00031	− ·00012	− ·00022	+ ·00019	+ ·00028	− ·00015
20 18 ...	+ ·00012	+ ·00019	− ·00012	− ·00031	− ·00028	− ·00050	− ·00056	− ·00037	− ·00009	− ·00006	+ ·00016	+ ·00031	− ·00013
21 18 ...	+ ·00009	+ ·00006	− ·00006	− ·00012	− ·00006	− ·00037	− ·00044	− ·00028	+ ·00003	− ·00009	+ ·00012	+ ·00022	− ·00007
22 18 ...	+ ·00009	+ ·00012	·00000	+ ·00003	+ ·00012	− ·00012	− ·00022	− ·00012	+ ·00009	+ ·00003	+ ·00019	+ ·00019	+ ·00003
23 18 ...	+ ·00016	+ ·00016	+ ·00009	+ ·00012	+ ·00028	+ ·00009	− ·00003	− ·00003	+ ·00022	+ ·00012	+ ·00025	+ ·00025	+ ·00014
0 18 ...	+ ·00022	+ ·00022	+ ·00016	+ ·00025	+ ·00037	+ ·00028	+ ·00012	+ ·00019	+ ·00025	+ ·00019	+ ·00022	+ ·00019	+ ·00022
1 18 ...	+ ·00012	+ ·00016	+ ·00009	+ ·00031	+ ·00040	+ ·00040	+ ·00034	+ ·00028	+ ·00022	+ ·00025	+ ·00016	+ ·00006	+ ·00023
2 18 ...	·00000	+ ·00009	·00000	+ ·00025	+ ·00047	+ ·00053	+ ·00044	+ ·00040	+ ·00034	+ ·00022	+ ·00006	− ·00006	+ ·00023
3 18 ...	− ·00016	− ·00003	− ·00009	+ ·00016	+ ·00040	+ ·00050	+ ·00047	+ ·00044	+ ·00031	+ ·00022	− ·00003	− ·00022	+ ·00016
4 18 ...	− ·00034	− ·00019	− ·00022	+ ·00003	+ ·00037	+ ·00056	+ ·00050	+ ·00047	+ ·00034	+ ·00012	− ·00019	− ·00037	+ ·00009
5 18 ...	− ·00053	− ·00040	− ·00028	− ·00003	+ ·00056	+ ·00075	+ ·00065	+ ·00069	+ ·00047	+ ·00006	− ·00031	− ·00053	+ ·00009
6 18 ...	− ·00072	− ·00044	− ·00031	+ ·00053	+ ·00171	+ ·00159	+ ·00143	+ ·00181	+ ·00143	+ ·00028	− ·00040	− ·00069	+ ·00052
7 18 ...	− ·00047	− ·00028	+ ·00034	+ ·00143	+ ·00237	+ ·00218	+ ·00190	+ ·00249	+ ·00234	+ ·00081	− ·00022	− ·00093	+ ·00100
8 18 ...	+ ·00022	− ·00019	+ ·00090	+ ·00156	+ ·00205	+ ·00209	+ ·00181	+ ·00209	+ ·00190	+ ·00078	+ ·00012	− ·00056	+ ·00106
9 18 ...	+ ·00062	− ·00025	+ ·00109	+ ·00090	+ ·00077	+ ·00121	+ ·00115	+ ·00056	+ ·00059	+ ·00019	+ ·00009	− ·00003	+ ·00057

Table 130.—Declination Magnetograph.

Showing the mean diurnal variation of declination for each month of the year 1876 *and for the whole year.*

1876. Bombay Civil Time.	MONTH.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 18 ...	+ ·00065	− ·00009	+ ·00050	+ ·00009	− ·00121	− ·00031	− ·00062	− ·00069	− ·00062	− ·00034	− ·00016	+ ·00006	− ·00023
11 18 ...	+ ·00003	− ·00025	− ·00025	− ·00097	− ·00206	− ·00150	− ·00159	− ·00174	− ·00190	− ·00131	− ·00072	− ·00009	− ·00103
12 18 ...	− ·00016	− ·00025	− ·00097	− ·00159	− ·00221	− ·00218	− ·00199	− ·00227	− ·00256	− ·00168	− ·00062	+ ·00006	− ·00137
13 18 ...	− ·00006	+ ·00012	− ·00106	− ·00143	− ·00171	− ·00212	− ·00199	− ·00218	− ·00237	− ·00115	− ·00012	+ ·00034	− ·00114
14 18 ..	− ·00016	+ ·00044	− ·00047	− ·00090	− ·00075	− ·00162	− ·00146	− ·00159	− ·00125	− ·00034	+ ·00003	+ ·00028	− ·00065
15 18 ...	+ ·00006	+ ·00062	+ ·00025	− ·00025	+ ·00003	− ·00093	− ·00075	− ·00065	− ·00022	+ ·00034	+ ·00022	+ ·00025	− ·00009
16 18 ...	+ ·00025	+ ·00065	+ ·00037	+ ·00009	+ ·00050	− ·00025	− ·00016	+ ·00006	+ ·00031	+ ·00044	+ ·00031	+ ·00037	+ ·00024
17 18 ...	+ ·00012	+ ·00031	+ ·00012	+ ·00006	+ ·00047	·00000	+ ·00006	+ ·00034	+ ·00012	+ ·00006	+ ·00019	+ ·00034	+ ·00018
18 18 ...	+ ·00003	·00000	− ·00009	− ·00025	− ·00012	− ·00016	− ·00012	+ ·00003	− ·00016	·00000	+ ·00025	+ ·00031	− ·00003
19 18 ...	+ ·00012	+ ·00003	− ·00022	− ·00034	− ·00037	− ·00047	− ·00047	− ·00031	− ·00025	+ ·00003	+ ·00022	+ ·00025	− ·00015
20 18 ...	+ ·00009	− ·00003	− ·00025	− ·00034	− ·00041	− ·00037	− ·00047	− ·00037	− ·00025	+ ·00016	+ ·00022	+ ·00019	− ·00015
21 18 ...	+ ·00009	− ·00009	− ·00019	− ·00028	− ·00028	− ·00034	− ·00025	− ·00016	+ ·00016	+ ·00022	+ ·00016	− ·00010	
22 18 ...	+ ·00009	·00000	− ·00012	− ·00003	− ·00006	− ·00009	− ·00016	− ·00009	− ·00006	+ ·00022	+ ·00031	+ ·00019	+ ·00002
23 18 ...	+ ·00012	+ ·00009	+ ·00003	+ ·00009	+ ·00016	+ ·00012	+ ·00006	·00000	+ ·00006	+ ·00031	+ ·00031	+ ·00016	+ ·00013
0 18 ...	+ ·00016	+ ·00009	+ ·00019	+ ·00019	+ ·00028	+ ·00028	+ ·00031	+ ·00009	+ ·00019	+ ·00028	+ ·00034	+ ·00016	+ ·00021
1 18 ...	+ ·00009	+ ·00009	+ ·00012	+ ·00031	+ ·00034	+ ·00037	+ ·00044	+ ·00022	+ ·00022	+ ·00031	+ ·00028	+ ·00003	+ ·00023
2 18 ...	− ·00003	− ·00003	+ ·00006	+ ·00031	+ ·00041	+ ·00047	+ ·00050	+ ·00034	+ ·00025	+ ·00025	+ ·00022	− ·00003	+ ·00023
3 18 ...	− ·00019	− ·00012	− ·00009	+ ·00025	+ ·00037	+ ·00047	+ ·00053	+ ·00034	+ ·00034	+ ·00019	+ ·00006	− ·00012	+ ·00017
4 18 ...	− ·00037	− ·00028	− ·00012	+ ·00016	+ ·00037	+ ·00044	+ ·00059	+ ·00047	+ ·00025	+ ·00003	− ·00009	− ·00034	+ ·00009
5 18 ...	− ·00059	− ·00053	− ·00025	+ ·00016	+ ·00062	+ ·00081	+ ·00093	+ ·00069	+ ·00044	− ·00003	− ·00028	− ·00047	+ ·00012
6 18 ...	− ·00075	− ·00053	− ·00006	+ ·00062	+ ·00156	+ ·00181	+ ·00196	+ ·00184	+ ·00118	+ ·00012	− ·00053	− ·00065	+ ·00054
7 18 ...	− ·00081	− ·00044	+ ·00056	+ ·00140	+ ·00209	+ ·00237	+ ·00234	+ ·00252	+ ·00333	+ ·00072	− ·00050	− ·00100	+ ·00105
8 18 ...	+ ·00009	− ·00003	+ ·00103	+ ·00140	+ ·00168	+ ·00202	+ ·00193	+ ·00218	+ ·00218	+ ·00084	− ·00006	− ·00062	+ ·00105
9 18 ...	+ ·00087	+ ·00009	+ ·00093	+ ·00100	+ ·00034	+ ·00093	+ ·00072	+ ·00087	+ ·00087	+ ·00044	+ ·00016	− ·00006	+ ·00058

Table 131.—Declination Magnetograph.

Showing the mean diurnal variation of declination for each month of the year 1877 *and for the whole year.*

1877. Bombay Civil Time.			MONTH.											Year.
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.	m.														
10	18	...	+ ·00059	+ ·00009	+ ·00041	+ ·00041	− ·00053	− ·00037	− ·00037	− ·00081	− ·00081	− ·00034	− ·00044	− ·00044	− ·00022
11	18	...	− ·00031	− ·00034	− ·00041	− ·00097	− ·00165	− ·00159	− ·00175	− ·00234	− ·00237	− ·00125	− ·00059	− ·00090	− ·00121
12	18	...	− ·00028	− ·00059	− ·00112	− ·00193	− ·00221	− ·00231	− ·00224	− ·00284	− ·00293	− ·00140	− ·00019	− ·00050	− ·00154
13	18	...	+ ·00009	− ·00019	− ·00118	− ·00184	− ·00203	− ·00206	− ·00215	− ·00256	− ·00224	− ·00081	+ ·00044	+ ·00016	− ·00120
14	18	...	·00000	+ ·00009	− ·00056	− ·00128	− ·00125	− ·00137	− ·00165	− ·00175	− ·00109	− ·00019	+ ·00053	+ ·00041	− ·00068
15	18	...	+ ·00016	+ ·00031	+ ·00025	− ·00047	− ·00047	− ·00075	− ·00097	− ·00075	+ ·00009	+ ·00040	+ ·00047	+ ·00059	− ·00009
16	18	...	+ ·00031	+ ·00044	+ ·00062	+ ·00012	+ ·00012	− ·00031	− ·00037	+ ·00012	+ ·00072	+ ·00052	+ ·00034	+ ·00053	+ ·00026
17	18	...	+ ·00009	+ ·00025	+ ·00044	+ ·00009	+ ·00025	− ·00003	− ·00012	+ ·00037	+ ·00050	+ ·00016	+ ·00028	+ ·00025	+ ·00021
18	18	...	+ ·00003	+ ·00003	+ ·00003	− ·00009	− ·00009	− ·00016	− ·00019	+ ·00003	− ·00012	+ ·00003	+ ·00028	+ ·00022	·00000
19	18	...	+ ·00009	+ ·00009	− ·00016	− ·00022	− ·00034	− ·00031	− ·00047	− ·00028	− ·00019	− ·00006	+ ·00009	+ ·00019	− ·00013
20	18	...	+ ·00003	+ ·00006	− ·00012	− ·00019	− ·00031	− ·00028	− ·00044	− ·00022	− ·00016	− ·00003	+ ·00012	+ ·00012	− ·00012
21	18	...	+ ·00009	+ ·00003	− ·00009	− ·00009	− ·00016	− ·00019	− ·00031	− ·00009	− ·00003	+ ·00006	+ ·00009	+ ·00006	− ·00005
22	18	...	+ ·00019	+ ·00009	− ·00006	+ ·00006	− ·00003	·00000	− ·00006	+ ·00006	+ ·00003	+ ·00016	+ ·00022	+ ·00006	+ ·00006
23	18	...	+ ·00012	+ ·00016	·00000	+ ·00012	+ ·00019	+ ·00016	+ ·00019	+ ·00016	+ ·00016	+ ·00022	+ ·00028	+ ·00012	+ ·00016
0	18	...	+ ·00016	+ ·00019	+ ·00006	+ ·00019	+ ·00031	+ ·00028	+ ·00037	+ ·00031	+ ·00019	+ ·00025	+ ·00028	+ ·00009	+ ·00022
1	18	...	+ ·00019	+ ·00012	·00000	+ ·00022	+ ·00031	+ ·00044	+ ·00053	+ ·00037	+ ·00028	+ ·00022	+ ·00019	+ ·00006	+ ·00024
2	18	...	+ ·00012	+ ·00012	·00000	+ ·00022	+ ·00037	+ ·00053	+ ·00059	+ ·00037	+ ·00031	+ ·00016	+ ·00006	− ·00003	+ ·00023
3	18	...	− ·00012	− ·00006	− ·00003	+ ·00016	+ ·00034	+ ·00056	+ ·00062	+ ·00047	+ ·00031	+ ·00003	− ·00003	− ·00012	+ ·00018
4	18	...	− ·00041	− ·00019	− ·00009	+ ·00003	+ ·00037	+ ·00053	+ ·00065	+ ·00053	+ ·00034	·00000	− ·00019	− ·00025	+ ·00011
5	18	...	− ·00062	− ·00031	− ·00009	+ ·00003	+ ·00053	+ ·00081	+ ·00078	+ ·00078	+ ·00056	− ·00003	− ·00034	− ·00034	+ ·00015
6	18	...	− ·00081	− ·00041	+ ·00003	+ ·00062	+ ·00140	+ ·00162	+ ·00184	+ ·00199	+ ·00140	+ ·00009	− ·00050	− ·00041	+ ·00057
7	18	...	− ·00087	− ·00031	+ ·00056	+ ·00162	+ ·00206	+ ·00218	+ ·00252	+ ·00281	+ ·00234	+ ·00069	− ·00047	− ·00028	+ ·00107
8	18	...	+ ·00009	+ ·00006	+ ·00090	+ ·00175	+ ·00190	+ ·00206	+ ·00228	+ ·00252	+ ·00218	+ ·00087	− ·00037	+ ·00028	+ ·00121
9	18	...	+ ·00106	+ ·00025	+ ·00087	+ ·00109	+ ·00081	+ ·00094	+ ·00109	+ ·00087	+ ·00084	+ ·00044	− ·00034	+ ·00028	+ ·00068

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TABLE 132.—DECLINATION MAGNETOGRAPH.

Showing the mean diurnal variation of declination for each month of the year 1878 and for the whole year.

1878. Bombay Civil Time.	MONTH. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00037	+ ·00006	+ ·00050	+ ·00012	− ·00056	− ·00041	+ ·00009	− ·00062	− ·00072	− ·00087	− ·00009	− ·00090	− ·00025
11 18 ...	− ·00053	− ·00044	− ·00062	− ·00125	− ·00150	− ·00137	− ·00106	− ·00143	− ·00178	− ·00147	− ·00044	− ·00106	− ·00108
12 18 ...	− ·00065	− ·00059	− ·00131	− ·00196	− ·00203	− ·00187	− ·00168	− ·00178	− ·00220	− ·00134	− ·00009	− ·00059	− ·00134
13 18 ...	− ·00028	− ·00028	− ·00118	− ·00171	− ·00168	− ·00175	− ·00193	− ·00175	− ·00190	− ·00059	+ ·00047	+ ·00016	− ·00103
14 18 ...	+ ·00003	+ ·00016	− ·00047	− ·00109	− ·00090	− ·00125	− ·00153	− ·00122	− ·00097	+ ·00028	+ ·00062	+ ·00062	− ·00048
15 18 ...	+ ·00037	+ ·00053	+ ·00034	− ·00041	− ·00034	− ·00072	− ·00084	− ·00044	·00000	+ ·00081	+ ·00056	+ ·00078	+ ·00005
16 18 ...	+ ·00053	+ ·00053	+ ·00050	+ ·00006	·00000	− ·00019	− ·00016	+ ·00016	+ ·00047	+ ·00065	+ ·00047	+ ·00066	+ ·00031
17 18 ...	+ ·00028	+ ·00019	+ ·00019	+ ·00012	− ·00003	− ·00012	− ·00003	+ ·00025	+ ·00028	− ·00003	+ ·00016	+ ·00037	+ ·00013
18 18 ...	+ ·00019	+ ·00003	− ·00009	− ·00019	− ·00028	− ·00031	− ·00022	− ·00012	− ·00006	− ·00019	+ ·00009	+ ·00034	− ·00007
19 18 ...	+ ·00019	+ ·00006	− ·00019	− ·00034	− ·00041	− ·00056	− ·00050	− ·00037	− ·00016	− ·00016	+ ·00009	+ ·00034	− ·00017
20 18 ...	+ ·00012	+ ·00003	− ·00012	− ·00025	− ·00034	− ·00037	− ·00050	− ·00040	− ·00012	− ·00006	+ ·00003	+ ·00031	− ·00014
21 18 ...	+ ·00009	·00000	− ·00006	− ·00006	− ·00019	− ·00025	− ·00034	− ·00025	− ·00006	− ·00003	+ ·00003	+ ·00028	− ·00007
22 18 ...	+ ·00009	+ ·00006	+ ·00003	+ ·00006	·00000	− ·00003	− ·00016	− ·00012	+ ·00006	+ ·00006	+ ·00003	+ ·00028	+ ·00003
23 18 ...	+ ·00009	+ ·00009	+ ·00009	+ ·00016	+ ·00016	+ ·00022	+ ·00006	+ ·00003	+ ·00019	+ ·00016	+ ·00009	+ ·00028	+ ·00013
0 18 ...	+ ·00006	+ ·00003	+ ·00009	+ ·00028	+ ·00031	+ ·00031	+ ·00025	+ ·00019	+ ·00028	+ ·00022	+ ·00012	+ ·00022	+ ·00020
1 18 ...	·00000	− ·00003	+ ·00006	+ ·00034	+ ·00041	+ ·00037	+ ·00034	+ ·00025	+ ·00031	+ ·00019	+ ·00006	+ ·00016	+ ·00020
2 18 ...	− ·00012	− ·00012	·00000	+ ·00028	+ ·00044	+ ·00041	+ ·00034	+ ·00031	+ ·00031	+ ·00022	+ ·00003	·00000	+ ·00017
3 18 ...	− ·00028	− ·00022	− ·00006	+ ·00016	+ ·00037	+ ·00041	+ ·00037	+ ·00034	+ ·00031	+ ·00016	− ·00012	− ·00016	+ ·00011
4 18 ...	− ·00044	− ·00031	− ·00019	+ ·00006	+ ·00034	+ ·00041	+ ·00041	+ ·00041	+ ·00025	+ ·00012	− ·00022	− ·00028	+ ·00004
5 18 ...	− ·00056	− ·00037	− ·00016	+ ·00009	+ ·00041	+ ·00069	+ ·00062	+ ·00059	+ ·00034	+ ·00016	− ·00037	− ·00041	+ ·00009
6 18 ...	− ·00059	− ·00034	− ·00003	+ ·00075	+ ·00119	+ ·00165	+ ·00153	+ ·00153	+ ·00115	+ ·00034	− ·00053	− ·00044	+ ·00052
7 18 ...	− ·00034	− ·00016	+ ·00059	+ ·00159	+ ·00184	+ ·00212	+ ·00196	+ ·00206	+ ·00193	+ ·00075	− ·00050	− ·00047	+ ·00095
8 18 ...	+ ·00059	+ ·00034	+ ·00112	+ ·00187	+ ·00181	+ ·00187	+ ·00181	+ ·00175	+ ·00162	+ ·00059	− ·00012	− ·00012	+ ·00109
9 18 ...	+ ·00094	+ ·00037	+ ·00106	+ ·00125	+ ·00081	+ ·00081	+ ·00106	+ ·00062	+ ·00050	− ·00009	− ·00003	− ·00022	+ ·00059

Table 133.—Declination Magnetograph

Showing the mean diurnal variation of declination for each month of the year 1879 and for the whole year.

1879.	MONTH.												Year.
Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 18 ...	+ ·00037	+ ·00041	+ ·00078	+ ·00003	− ·00081	− ·00037	− ·00012	− ·00081	− ·00075	− ·00044	− ·00059	− ·00022	− ·00021
11 18 ...	− ·00072	− ·00019	+ ·00003	− ·00094	− ·00190	− ·00175	− ·00156	− ·00203	− ·00190	− ·00125	− ·00100	− ·00028	− ·00112
12 18 ...	− ·00094	− ·00025	− ·00087	− ·00137	− ·00234	− ·00243	− ·00231	− ·00250	− ·00253	− ·00128	− ·00053	− ·00006	− ·00145
13 18 ...	− ·00044	·00000	− ·00122	− ·00131	− ·00193	− ·00218	− ·00222	− ·00231	− ·00218	− ·00075	+ ·00019	+ ·00050	− ·00115
14 18 ...	− ·00006	+ ·00022	− ·00069	− ·00072	− ·00115	− ·00147	− ·00156	− ·00147	− ·00106	·00000	+ ·00056	+ ·00069	− ·00056
15 18 ...	+ ·00019	+ ·00047	·00000	− ·00012	− ·00031	− ·00075	− ·00072	− ·00044	+ ·00003	+ ·00056	+ ·00072	+ ·00050	+ ·00001
16 18 ...	+ ·00041	+ ·00047	+ ·00034	+ ·00034	+ ·00034	− ·00009	− ·00009	+ ·00031	+ ·00062	+ ·00050	+ ·00044	+ ·00047	+ ·00034
17 18 ...	+ ·00031	+ ·00009	+ ·00019	+ ·00022	+ ·00037	+ ·00012	+ ·00009	+ ·00044	+ ·00044	+ ·00003	+ ·00012	+ ·00037	+ ·00023
18 18 ...	+ ·00028	− ·00003	− ·00006	− ·00006	− ·00009	− ·00012	− ·00009	− ·00003	·00000	− ·00009	+ ·00016	+ ·00025	+ ·00001
19 18 ...	+ ·00025	·00000	− ·00019	− ·00025	− ·00028	− ·00041	− ·00047	− ·00028	− ·00019	− ·00012	+ ·00012	+ ·00022	− ·00013
20 18 ...	+ ·00022	·00000	− ·00016	− ·00031	− ·00028	− ·00037	− ·00044	− ·00034	− ·00019	− ·00012	+ ·00012	+ ·00019	− ·00014
21 18 ...	+ ·00019	·00000	− ·00006	− ·00019	− ·00009	− ·00025	− ·00028	− ·00022	− ·00006	− ·00003	+ ·00012	+ ·00019	− ·00006
22 18 ...	+ ·00019	+ ·00006	− ·00003	− ·00009	+ ·00009	·00000	− ·00006	− ·00006	+ ·00006	+ ·00006	+ ·00019	+ ·00019	+ ·00005
23 18 ...	+ ·00019	+ ·00006	+ ·00006	·00000	+ ·00021	+ ·00016	+ ·00012	+ ·00006	+ ·00016	+ ·00012	+ ·00025	+ ·00022	+ ·00013
0 18 ...	+ ·00022	+ ·00006	+ ·00009	+ ·00009	+ ·00034	+ ·00028	+ ·00025	+ ·00022	+ ·00025	+ ·00016	+ ·00028	+ ·00028	+ ·00021
1 18 ...	+ ·00012	·00000	+ ·00003	+ ·00012	+ ·00041	+ ·00037	+ ·00031	+ ·00031	+ ·00028	+ ·00019	+ ·00025	+ ·00022	+ ·00022
2 18 ...	+ ·00006	− ·00006	·00000	+ ·00009	+ ·00037	+ ·00041	+ ·00034	+ ·00041	+ ·00028	+ ·00016	+ ·00012	+ ·00009	+ ·00019
3 18 ...	− ·00012	− ·00019	− ·00009	+ ·00006	+ ·00037	+ ·00037	+ ·00037	+ ·00044	+ ·00025	+ ·00006	·00000	− ·00009	+ ·00012
4 18 ...	− ·00025	− ·00028	− ·00016	+ ·00003	+ ·00034	+ ·00037	+ ·00041	+ ·00047	+ ·00031	− ·00003	− ·00019	− ·00034	+ ·00006
5 18 ...	− ·00037	− ·00037	− ·00016	+ ·00006	+ ·00062	+ ·00072	+ ·00069	+ ·00072	+ ·00047	− ·00009	− ·00031	− ·00053	+ ·00012
6 18 ...	− ·00044	− ·00053	− ·00012	+ ·00069	+ ·00159	+ ·00178	+ ·00172	+ ·00181	+ ·00122	+ ·00012	− ·00044	− ·00072	+ ·00056
7 18 ...	− ·00034	− ·00050	+ ·00041	+ ·00144	+ ·00209	+ ·00234	+ ·00222	+ ·00247	+ ·00209	+ ·00081	− ·00041	− ·00112	+ ·00096
8 18 ...	+ ·00019	+ ·00012	+ ·00087	+ ·00134	+ ·00181	+ ·00212	+ ·00206	+ ·00212	+ ·00178	+ ·00103	− ·00012	− ·00084	+ ·00104
9 18 ...	+ ·00066	+ ·00050	+ ·00094	+ ·00090	+ ·00056	+ ·00094	+ ·00097	+ ·00084	+ ·00053	+ ·00037	− ·00016	− ·00034	+ ·00056

Table 134.—Declination Magnetograph.

Showing the mean diurnal variation of declination for each month of the year 1880 *and for the whole year.*

1880. Bombay Civil Time.	MONTH.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 18 ...	+ ·00028	+ ·00078	+ ·00128	+ ·00044	− ·00056	− ·00009	− ·00022	− ·00047	− ·00050	− ·00066	+ ·00009	− ·00012	+ ·00007
11 18 ...	+ ·00012	+ ·00003	+ ·00041	− ·00091	− ·00150	− ·00147	− ·00128	− ·00172	− ·00194	− ·00097	− ·00037	− ·00037	− ·00083
12 18 ...	− ·00003	− ·00050	− ·00066	− ·00184	− ·00206	− ·00234	− ·00184	− ·00234	− ·00256	− ·00131	− ·00031	− ·00019	− ·00133
13 18 ...	+ ·00031	− ·00041	− ·00087	− ·00187	− ·00184	− ·00237	− ·00181	− ·00231	− ·00228	− ·00084	− ·00003	+ ·00022	− ·00117
14 18 ...	+ ·00044	− ·00016	− ·00047	− ·00131	− ·00116	− ·00178	− ·00144	− ·00175	− ·00125	− ·00028	− ·00006	+ ·00037	− ·00074
15 18 ...	+ ·00047	+ ·00012	+ ·00016	− ·00053	− ·00044	− ·00094	− ·00078	− ·00091	− ·00019	+ ·00028	+ ·00003	+ ·00041	− ·00019
16 18 ...	+ ·00050	+ ·00031	+ ·00028	+ ·00009	+ ·00003	− ·00025	− ·00028	− ·00037	+ ·00037	+ ·00034	+ ·00012	+ ·00047	+ ·00013
17 18 ...	+ ·00037	+ ·00009	− ·00016	+ ·00022	+ ·00019	·00000	− ·00009	·00000	+ ·00019	− ·00012	− ·00009	+ ·00028	+ ·00007
18 18 ...	+ ·00031	− ·00012	− ·00044	− ·00012	− ·00009	− ·00006	− ·00016	− ·00006	− ·00012	− ·00022	+ ·00006	+ ·00037	− ·00005
19 18 ...	+ ·00028	− ·00003	− ·00041	− ·00031	− ·00031	− ·00031	− ·00053	− ·00037	− ·00012	− ·00003	+ ·00012	+ ·00037	− ·00014
20 18 ...	+ ·00025	− ·00003	− ·00019	− ·00022	− ·00028	− ·00031	− ·00059	− ·00031	− ·00006	− ·00009	+ ·00022	+ ·00031	− ·00011
21 18 ...	+ ·00016	− ·00003	− ·00012	− ·00003	− ·00016	− ·00022	− ·00050	− ·00016	·00000	·00000	+ ·00028	+ ·00034	− ·00004
22 18 ...	+ ·00019	·00000	− ·00006	+ ·00006	+ ·00006	− ·00006	− ·00028	·00000	+ ·00006	+ ·00009	+ ·00031	+ ·00037	+ ·00006
23 18 ...	+ ·00016	+ ·00006	+ ·00003	+ ·00022	+ ·00019	+ ·00016	− ·00012	+ ·00019	+ ·00009	+ ·00022	+ ·00041	+ ·00034	+ ·00016
0 18 ...	+ ·00012	+ ·00006	+ ·00009	+ ·00028	+ ·00025	+ ·00031	+ ·00019	+ ·00034	+ ·00019	+ ·00025	+ ·00031	+ ·00031	+ ·00022
1 18 ...	+ ·00006	+ ·00006	+ ·00003	+ ·00037	+ ·00034	+ ·00041	+ ·00028	+ ·00044	+ ·00025	+ ·00019	+ ·00019	+ ·00022	+ ·00024
2 18 ...	− ·00009	+ ·00003	− ·00006	+ ·00031	+ ·00037	+ ·00047	+ ·00037	+ ·00044	+ ·00031	+ ·00012	+ ·00006	+ ·00012	+ ·00020
3 18 ...	− ·00022	− ·00009	− ·00022	+ ·00025	+ ·00034	+ ·00044	+ ·00044	+ ·00050	+ ·00025	− ·00016	− ·00019	− ·00022	+ ·00009
4 18 ...	− ·00037	− ·00019	− ·00037	+ ·00016	+ ·00031	+ ·00041	+ ·00047	+ ·00047	+ ·00022	− ·00031	− ·00041	− ·00044	·00000
5 18 ...	− ·00059	− ·00034	− ·00050	+ ·00009	+ ·00050	+ ·00069	+ ·00075	+ ·00072	+ ·00028	− ·00031	− ·00053	− ·00072	·00000
6 18 ...	− ·00072	− ·00044	− ·00059	+ ·00047	+ ·00147	+ ·00165	+ ·00184	+ ·00172	+ ·00119	·00000	− ·00069	− ·00081	+ ·00042
7 18 ...	− ·00100	− ·00016	+ ·00016	+ ·00131	+ ·00200	+ ·00228	+ ·00231	+ ·00250	+ ·00219	+ ·00087	− ·00034	− ·00103	+ ·00092
8 18 ...	− ·00069	+ ·00037	+ ·00103	+ ·00162	+ ·00184	+ ·00222	+ ·00200	+ ·00219	+ ·00222	+ ·00131	+ ·00025	− ·00056	+ ·00115
9 18 ...	− ·00009	+ ·00091	+ ·00144	+ ·00140	+ ·00075	+ ·00119	+ ·00091	+ ·00097	+ ·00106	+ ·00081	+ ·00044	− ·00006	+ ·00081

Table 135.—Declination Magnetograph.

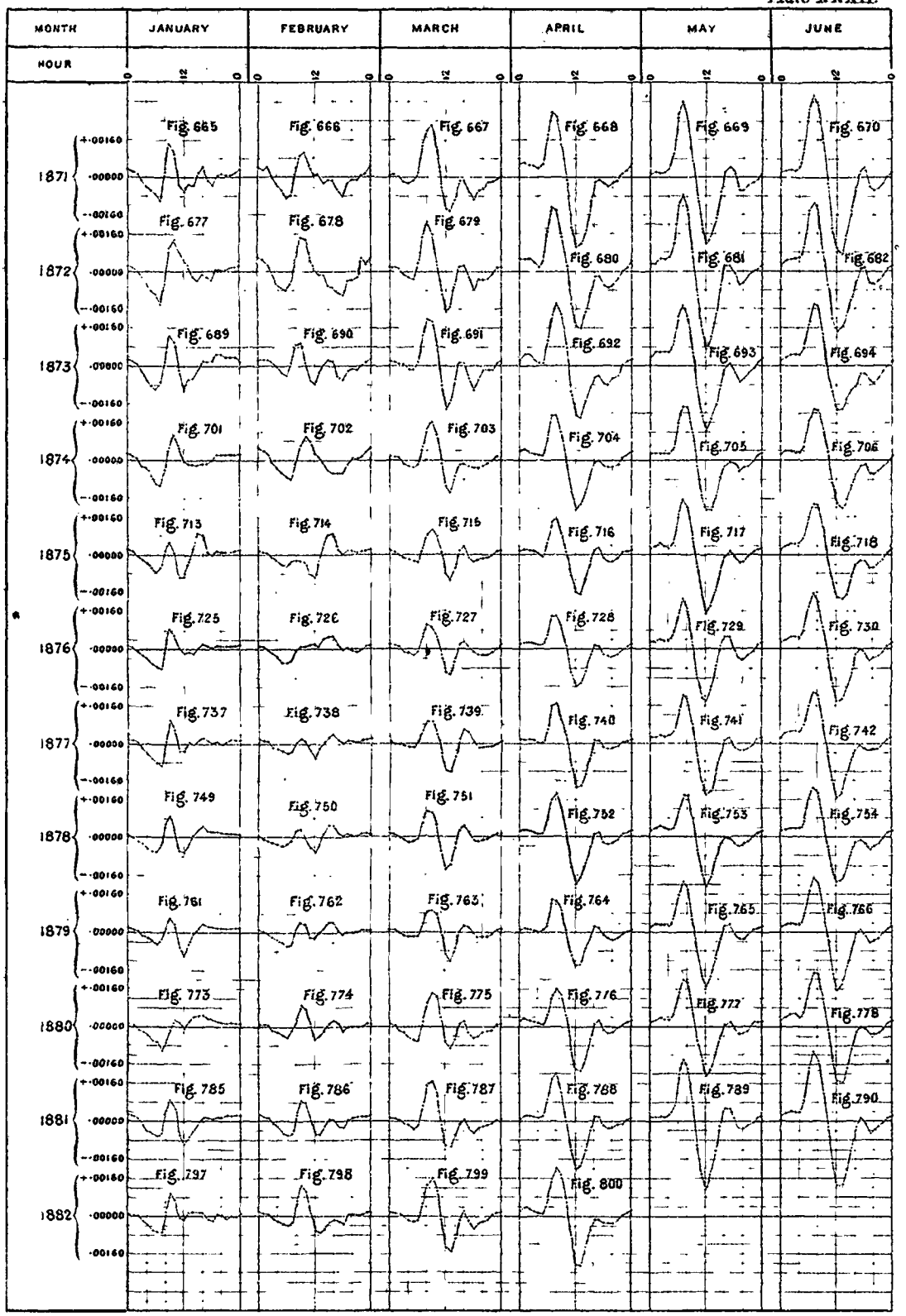
Showing the mean diurnal variation of declination for each month of the year 1881 *and for the whole year.*

1881. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00047	+ ·00081	+ ·00103	+ ·00003	− ·00100	− ·00025	− ·00050	− ·00053	− ·00047	− ·00009	− ·00009	+ ·00034	− ·00002
11 18 ...	− ·00056	+ ·00003	− ·00012	− ·00122	− ·00231	− ·00178	− ·00172	− ·00197	− ·00206	− ·00125	− ·00066	+ ·00003	− ·00113
12 18 ...	− ·00094	− ·00056	− ·00103	− ·00200	− ·00284	− ·00275	− ·00225	− ·00272	− ·00300	− ·00162	− ·00047	+ ·00003	− ·00168
13 18 ...	− ·00066	− ·00053	− ·00109	− ·00187	− ·00231	− ·00272	− ·00212	− ·00269	− ·00281	− ·00109	+ ·00019	+ ·00044	− ·00144
14 18 ...	− ·00031	− ·00025	− ·00062	− ·00119	− ·00125	− ·00209	− ·00156	− ·00194	− ·00175	− ·00022	+ ·00041	+ ·00041	− ·00086
15 18 ...	− ·00003	+ ·00006	− ·00009	− ·00041	− ·00019	− ·00112	− ·00072	− ·00087	− ·00059	+ ·00028	+ ·00056	+ ·00028	− ·00024
16 18 ...	+ ·00019	+ ·00003	+ ·00003	+ ·00022	+ ·00056	− ·00025	·00000	+ ·00009	+ ·00009	+ ·00031	+ ·00053	+ ·00022	− ·00017
17 18 ...	+ ·00012	− ·00019	− ·00028	+ ·00019	+ ·00053	+ ·00009	+ ·00041	+ ·00034	+ ·00003	− ·00025	+ ·00006	+ ·00009	+ ·00009
18 18 ...	+ ·00009	− ·00022	− ·00050	− ·00016	+ ·00006	− ·00006	+ ·00025	+ ·00003	− ·00009	− ·00034	+ ·00019	+ ·00009	− ·00006
19 18 ...	+ ·00025	+ ·00003	− ·00031	− ·00034	− ·00034	− ·00050	− ·00047	− ·00037	− ·00016	− ·00019	+ ·00022	+ ·00022	− ·00016
20 18 ...	+ ·00025	+ ·00012	− ·00019	− ·00031	− ·00034	− ·00037	− ·00053	− ·00044	− ·00016	− ·00003	+ ·00006	+ ·00019	− ·00015
21 18 ...	+ ·00028	+ ·00019	− ·00012	− ·00012	− ·00016	− ·00019	− ·00047	− ·00034	− ·00003	− ·00006	+ ·00009	+ ·00016	− ·00006
22 18 ...	+ ·00025	+ ·00019	− ·00003	− ·00009	− ·00003	− ·00003	− ·00031	− ·00016	+ ·00009	+ ·00003	+ ·00019	+ ·00006	+ ·00001
23 18 ...	+ ·00031	+ ·00022	+ ·00003	+ ·00003	+ ·00009	+ ·00009	− ·00022	− ·00003	+ ·00037	+ ·00019	+ ·00016	+ ·00022	+ ·00012
0 18 ...	+ ·00031	+ ·00028	+ ·00009	+ ·00009	+ ·00022	+ ·00028	·00000	+ ·00016	+ ·00047	+ ·00022	+ ·00022	+ ·00028	+ ·00022
1 18 ...	+ ·00028	+ ·00022	+ ·00006	+ ·00022	+ ·00025	+ ·00037	+ ·00019	+ ·00022	+ ·00053	+ ·00019	+ ·00016	+ ·00019	+ ·00024
2 18 ...	+ ·00009	+ ·00012	·00000	+ ·00025	+ ·00025	+ ·00044	+ ·00025	+ ·00028	+ ·00059	+ ·00012	+ ·00006	+ ·00003	+ ·00021
3 18 ...	− ·00012	− ·00003	− ·00006	+ ·00016	+ ·00022	+ ·00041	+ ·00031	+ ·00031	+ ·00050	− ·00003	− ·00016	− ·00022	+ ·00011
4 18 ...	− ·00037	− ·00025	− ·00012	+ ·00012	+ ·00031	+ ·00041	+ ·00044	+ ·00037	+ ·00041	− ·00016	− ·00028	− ·00044	+ ·00004
5 18 ...	− ·00050	− ·00053	− ·00028	+ ·00019	+ ·00069	+ ·00087	+ ·00094	+ ·00072	+ ·00047	− ·00019	− ·00044	− ·00069	+ ·00010
6 18 ...	− ·00066	− ·00059	− ·00016	+ ·00087	+ ·00197	+ ·00231	+ ·00231	+ ·00222	+ ·00153	+ ·00034	− ·00062	− ·00084	+ ·00072
7 18 ...	− ·00047	− ·00046	+ ·00072	+ ·00181	+ ·00259	+ ·00297	+ ·00291	+ ·00312	+ ·00272	+ ·00128	− ·00047	− ·00109	+ ·00129
8 18 ...	+ ·00044	+ ·00034	+ ·00147	+ ·00200	+ ·00222	+ ·00253	+ ·00241	+ ·00272	+ ·00244	+ ·00166	+ ·00009	− ·00053	+ ·00148
9 18 ...	+ ·00097	+ ·00094	+ ·00166	+ ·00122	+ ·00078	+ ·00119	+ ·00091	+ ·00116	+ ·00097	+ ·00094	+ ·00034	+ ·00019	+ ·00094

COLABA OBSERVATORY.

DECLINATION MAGNETOGRAPH DIURNAL VARIATION.

Plate XXXII.



COLABA OBSERVATORY.

DECLINATION MAGNETOGRAPH. DIURNAL VARIATION.

Plate XXXII *Continued.*

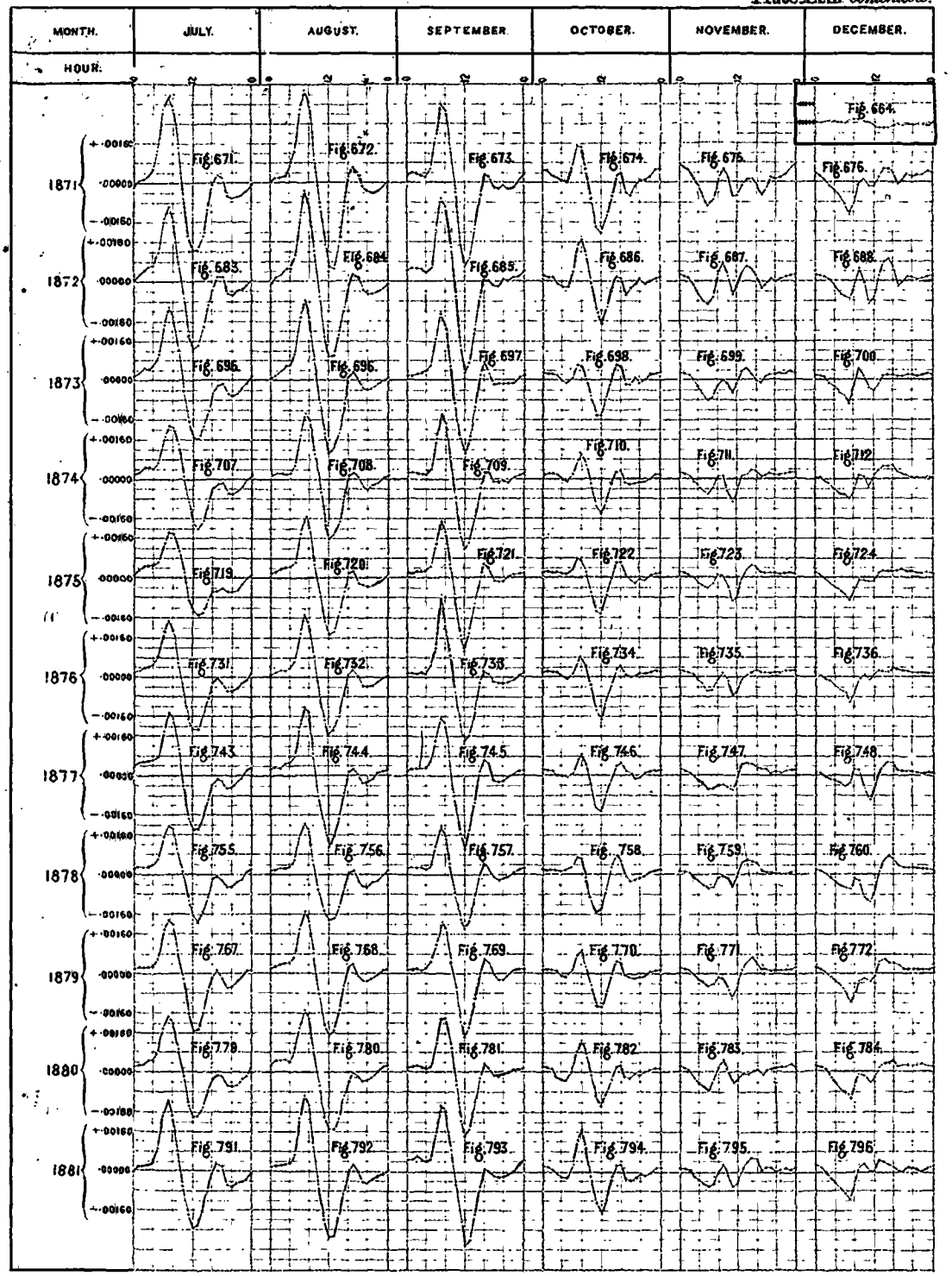


Table 136.—Declination Magnetograph.

Showing the mean diurnal variation of declination for the months January to April of the year 1882.

1882. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 18 ...	+ ·00075	+ ·00109	+ ·00112	+ ·00059									
11 18 ...	− ·00003	+ ·00012	− ·00006	− ·00094									
12 18 ...	− ·00012	− ·00065	− ·00134	− ·00206									
13 18 ...	+ ·00012	− ·00072	− ·00153	− ·00209									
14 18 ...	+ ·00019	− ·00056	− ·00094	− ·00131									
15 18 ...	+ ·00019	− ·00025	− ·00006	− ·00056									
16 18 ...	+ ·00019	− ·00012	+ ·00025	− ·00012									
17 18 ...	− ·00006	− ·00022	− ·00016	− ·00009									
18 18 ...	− ·00012	− ·00034	− ·00047	− ·00022									
19 18 ...	+ ·00006	+ ·00003	− ·00031	− ·00025									
20 18 ...	+ ·00003	+ ·00006	− ·00019	− ·00025									
21 18 ...	− ·00006	+ ·00003	− ·00009	− ·00012									
22 18 ...	·00000	+ ·00006	+ ·00006	+ ·00003									
23 18 ...	·00000	+ ·00016	+ ·00016	+ ·00012									
0 18 ...	+ ·00006	+ ·00019	+ ·00019	+ ·00028									
1 18 ...	+ ·00003	+ ·00012	+ ·00016	+ ·00041									
2 18 ...	+ ·00003	+ ·00006	+ ·00012	+ ·00037									
3 18 ...	− ·00016	− ·00009	·00000	+ ·00022									
4 18 ...	− ·00037	− ·00022	− ·00012	+ ·00012									
5 18 ...	− ·00059	− ·00037	− ·00022	+ ·00009									
6 18 ...	− ·00069	− ·00041	− ·00016	+ ·00075									
7 18 ...	− ·00069	− ·00025	+ ·00050	+ ·00162									
8 18 ...	+ ·00019	+ ·00072	+ ·00134	+ ·00203									
9 18 ...	+ ·00100	+ ·00128	+ ·00159	+ ·00175									

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Table 137.—Horizontal Force Magnetograph.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1872 *and for the whole year.*

1872. Bombay Civil Time.		MONTH.												Year.
h.	m.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
10	19 ...	+ ·00319	+ ·00459	+ ·00487	+ ·00567	+ ·00524	+ ·00414	+ ·00466	+ ·00405	+ ·00397	+ ·00416	+ ·00413	+ ·00354	+ ·00435
11	19 ...	+ ·00380	+ ·00492	+ ·00545	+ ·00596	+ ·00528	+ ·00443	+ ·00441	+ ·00451	+ ·00457	+ ·00441	+ ·00430	+ ·00375	+ ·00465
12	19 ...	+ ·00358	+ ·00452	+ ·00483	+ ·00501	+ ·00449	+ ·00405	+ ·00407	+ ·00417	+ ·00435	+ ·00348	+ ·00344	+ ·00333	+ ·00411
13	19 ...	+ ·00258	+ ·00328	+ ·00351	+ ·00377	+ ·00328	+ ·00322	+ ·00294	+ ·00341	+ ·00364	+ ·00170	+ ·00221	+ ·00243	+ ·00300
14	19 ...	+ ·00144	+ ·00179	+ ·00206	+ ·00199	+ ·00187	+ ·00184	+ ·00189	+ ·00211	+ ·00237	− ·00004	+ ·00106	+ ·00145	+ ·00165
15	19 ...	+ ·00057	+ ·00088	+ ·00066	+ ·00074	+ ·00050	+ ·00063	+ ·00059	+ ·00080	+ ·00110	− ·00089	+ ·00009	+ ·00081	+ ·00054
16	19 ...	− ·00039	+ ·00034	− ·00017	− ·00033	− ·00042	− ·00054	− ·00055	− ·00025	+ ·00025	− ·00110	− ·00085	− ·00009	− ·00034
17	19 ...	− ·00074	+ ·00012	− ·00116	− ·00074	− ·00096	− ·00113	− ·00139	− ·00093	− ·00034	− ·00149	− ·00123	− ·00064	− ·00089
18	19 ...	− ·00087	− ·00041	− ·00161	− ·00108	− ·00150	− ·00138	− ·00185	− ·00110	− ·00097	− ·00161	− ·00123	− ·00068	− ·00119
19	19 ...	− ·00122	− ·00043	− ·00202	− ·00141	− ·00166	− ·00130	− ·00185	− ·00135	− ·00169	− ·00174	− ·00174	− ·00111	− ·00146
20	19 ...	− ·00162	− ·00085	− ·00223	− ·00194	− ·00212	− ·00150	− ·00197	− ·00160	− ·00169	− ·00191	− ·00225	− ·00158	− ·00177
21	19 ...	− ·00210	− ·00199	− ·00223	− ·00186	− ·00237	− ·00163	− ·00181	− ·00177	− ·00182	− ·00208	− ·00225	− ·00192	− ·00199
22	19 ...	− ·00210	− ·00390	− ·00227	− ·00228	− ·00233	− ·00180	− ·00151	− ·00152	− ·00203	− ·00149	− ·00191	− ·00183	− ·00208
23	19 ...	− ·00175	− ·00435	− ·00235	− ·00244	− ·00233	− ·00192	− ·00164	− ·00148	− ·00203	− ·00127	− ·00170	− ·00192	− ·00210
0	19 ...	− ·00157	− ·00344	− ·00190	− ·00257	− ·00216	− ·00167	− ·00172	− ·00152	− ·00203	− ·00093	− ·00136	− ·00188	− ·00190
1	19 ...	− ·00131	− ·00315	− ·00182	− ·00232	− ·00204	− ·00134	− ·00193	− ·00173	− ·00169	− ·00068	− ·00102	− ·00166	− ·00172
2	19 ...	− ·00122	− ·00272	− ·00178	− ·00215	− ·00212	− ·00159	− ·00172	− ·00164	− ·00152	− ·00042	− ·00115	− ·00119	− ·00160
3	19 ...	− ·00114	− ·00176	− ·00145	− ·00203	− ·00183	− ·00163	− ·00202	− ·00186	− ·00127	− ·00013	− ·00111	− ·00128	− ·00146
4	19 ...	− ·00096	− ·00138	− ·00136	− ·00203	− ·00187	− ·00171	− ·00189	− ·00160	− ·00135	+ ·00025	− ·00094	− ·00094	− ·00131
5	19 ...	− ·00087	− ·00097	− ·00107	− ·00190	− ·00175	− ·00176	− ·00160	− ·00156	− ·00135	− ·00055	− ·00085	− ·00077	− ·00125
6	19 ...	− ·00035	− ·00055	− ·00112	− ·00161	− ·00116	− ·00117	− ·00084	− ·00135	− ·00135	− ·00064	− ·00030	− ·00047	− ·00091
7	19 ...	+ ·00035	+ ·00030	− ·00045	− ·00091	+ ·00012	− ·00013	+ ·00042	− ·00046	− ·00127	− ·00030	+ ·00060	+ ·00013	− ·00013
8	19 ...	+ ·00100	+ ·00201	+ ·00112	+ ·00124	+ ·00179	+ ·00125	+ ·00202	+ ·00067	+ ·00008	+ ·00110	+ ·00170	+ ·00094	+ ·00124
9	19 ...	+ ·00197	+ ·00315	+ ·00293	− ·00356	+ ·00357	+ ·00230	+ ·00370	+ ·00202	+ ·00216	+ ·00238	+ ·00285	+ ·00205	+ ·00272
Average progressive increase *per* day ...		− ·00051	+ ·00006	− ·00018	− ·00054	− ·00046	− ·00059	− ·00053	− ·00040	− ·00042	− ·00035	− ·00022	− ·00031	− ·00037

Table 138.—Horizontal Force Magnetograph.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1873 *and for the whole year.*

1873. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 19 ...	+ ·00295	+ ·00420	+ ·00468	+ ·00525	+ ·00345	+ ·00281	+ ·00312	+ ·00335	+ ·00314	+ ·00304	+ ·00288	+ ·00239	+ ·00344
11 19 ...	+ ·00359	+ ·00488	+ ·00524	+ ·00538	+ ·00371	+ ·00290	+ ·00343	+ ·00365	+ ·00357	+ ·00333	+ ·00293	+ ·00243	+ ·00375
12 19 ...	+ ·00325	+ ·00441	+ ·00468	+ ·00443	+ ·00293	+ ·00290	+ ·00330	+ ·00352	+ ·00348	+ ·00271	+ ·00247	+ ·00219	+ ·00336
13 19 ...	+ ·00218	+ ·00334	+ ·00326	+ ·00323	+ ·00216	+ ·00242	+ ·00282	+ ·00283	+ ·00274	+ ·00169	+ ·00148	+ ·00144	+ ·00247
14 19 ...	+ ·00120	+ ·00193	+ ·00172	+ ·00194	+ ·00129	+ ·00143	+ ·00174	+ ·00178	+ ·00157	+ ·00082	+ ·00054	+ ·00074	+ ·00139
15 19 ...	+ ·00034	+ ·00051	+ ·00052	+ ·00086	+ ·00052	+ ·00009	+ ·00048	+ ·00052	+ ·00048	− ·00021	− ·00004	+ ·00017	+ ·00035
16 19 ...	− ·00013	− ·00064	− ·00034	+ ·00026	− ·00052	− ·00056	− ·00022	− ·00043	− ·00026	− ·00074	− ·00045	− ·00012	− ·00035
17 19 ...	− ·00081	− ·00111	− ·00047	− ·00060	− ·00095	− ·00160	− ·00117	− ·00109	− ·00096	− ·00107	− ·00111	− ·00058	− ·00096
18 19 ...	− ·00090	− ·00133	− ·00099	− ·00099	− ·00129	− ·00186	− ·00134	− ·00130	− ·00122	− ·00115	− ·00091	− ·00062	− ·00116
19 19 ...	− ·00120	− ·00141	− ·00146	− ·00155	− ·00121	− ·00160	− ·00143	− ·00165	− ·00144	− ·00140	− ·00128	− ·00095	− ·00138
20 19 ...	− ·00192	− ·00167	− ·00189	− ·00185	− ·00108	− ·00130	− ·00147	− ·00161	− ·00166	− ·00156	− ·00136	− ·00103	− ·00153
21 19 ...	− ·00175	− ·00214	− ·00227	− ·00206	− ·00129	− ·00134	− ·00152	− ·00174	− ·00174	− ·00164	− ·00136	− ·00124	− ·00167
22 19 ...	− ·00162	− ·00210	− ·00215	− ·00237	− ·00142	− ·00130	− ·00117	− ·00152	− ·00179	− ·00148	− ·00124	− ·00140	− ·00163
23 19 ...	− ·00128	− ·00176	− ·00232	− ·00224	− ·00134	− ·00125	− ·00104	− ·00156	− ·00135	− ·00127	− ·00119	− ·00144	− ·00150
0 19 ...	− ·00120	− ·00137	− ·00219	− ·00219	− ·00138	− ·00121	− ·00108	− ·00122	− ·00113	− ·00115	− ·00111	− ·00103	− ·00135
1 19 ...	− ·00103	− ·00167	− ·00206	− ·00202	− ·00134	− ·00108	− ·00117	− ·00113	− ·00109	− ·00082	− ·00095	− ·00087	− ·00127
2 19 ...	− ·00103	− ·00171	− ·00189	− ·00189	− ·00142	− ·00113	− ·00130	− ·00117	− ·00087	− ·00070	− ·00103	− ·00083	− ·00125
3 19 ...	− ·00081	− ·00150	− ·00185	− ·00159	− ·00121	− ·00078	− ·00126	− ·00122	− ·00078	− ·00066	− ·00091	− ·00078	− ·00111
4 19 ...	− ·00086	− ·00158	− ·00133	− ·00163	− ·00121	− ·00039	− ·00126	− ·00113	− ·00074	− ·00053	− ·00074	− ·00066	− ·00100
5 19 ...	− ·00077	− ·00141	− ·00129	− ·00172	− ·00112	− ·00056	− ·00121	− ·00096	− ·00061	− ·00049	− ·00049	− ·00054	− ·00093
6 19 ...	− ·00060	− ·00116	− ·00120	− ·00159	− ·00078	− ·00009	− ·00087	− ·00074	− ·00065	− ·00033	− ·00004	− ·00025	− ·00069
7 19 ...	− ·00013	− ·00060	− ·00047	− ·00069	− ·00022	+ ·00043	− ·00004	− ·00048	− ·00061	+ ·00008	+ ·00070	+ ·00037	− ·00014
8 19 ...	+ ·00068	+ ·00081	+ ·00099	+ ·00052	+ ·00112	+ ·00104	+ ·00082	+ ·00087	+ ·00022	+ ·00119	+ ·00140	+ ·00099	+ ·00089
9 19 ...	+ ·00154	+ ·00257	+ ·00270	+ ·00262	+ ·00246	+ ·00182	+ ·00208	+ ·00226	+ ·00170	+ ·00222	+ ·00210	+ ·00169	+ ·00215
Average progressive increase *per* day ...	− ·00022	− ·00015	− ·00020	− ·00036	− ·00033	− ·00043	− ·00031	− ·00023	− ·00025	− ·00013	− ·00013	− ·00014	− ·00024

Table 139.—Horizontal Force Magnetograph.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1874 *and for the whole year.*

1874. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 19 ...	+ ·00277	+ ·00344	+ ·00406	+ ·00403	+ ·00336	+ ·00296	+ ·00275	+ ·00276	+ ·00259	+ ·00239	+ ·00290	+ ·00231	+ ·00303
11 19 ...	+ ·00314	+ ·00373	+ ·00435	+ ·00415	+ ·00353	+ ·00333	+ ·00342	+ ·00326	+ ·00318	+ ·00289	+ ·00281	+ ·00248	+ ·00336
12 19 ...	+ ·00256	+ ·00315	+ ·00356	+ ·00357	+ ·00307	+ ·00312	+ ·00346	+ ·00322	+ ·00289	+ ·00239	+ ·00210	+ ·00210	+ ·00293
13 19 ...	+ ·00161	+ ·00224	+ ·00228	+ ·00232	+ ·00233	+ ·00233	+ ·00284	+ ·00246	+ ·00197	+ ·00130	+ ·00122	+ ·00155	+ ·00204
14 19 ...	+ ·00087	+ ·00112	+ ·00087	+ ·00124	+ ·00133	+ ·00154	+ ·00175	+ ·00150	+ ·00109	+ ·00034	+ ·00076	+ ·00084	+ ·00110
15 19 ...	+ ·00025	+ ·00029	− ·00033	+ ·00037	+ ·00029	+ ·00042	+ ·00058	+ ·00033	+ ·00029	− ·00025	·00000	+ ·00021	+ ·00020
16 19 ...	− ·00037	− ·00021	− ·00070	− ·00046	− ·00037	− ·00033	− ·00042	− ·00050	− ·00021	− ·00054	− ·00029	− ·00046	− ·00040
17 19 ...	− ·00079	− ·00054	− ·00087	− ·00108	− ·00075	− ·00079	− ·00096	− ·00084	− ·00050	− ·00071	− ·00088	− ·00097	− ·00081
18 19 ...	− ·00095	− ·00046	− ·00099	− ·00174	− ·00116	− ·00121	− ·00121	− ·00100	− ·00054	− ·00088	− ·00105	− ·00097	− ·00101
19 19 ...	− ·00103	− ·00070	− ·00120	− ·00203	− ·00141	− ·00133	− ·00133	− ·00125	− ·00075	− ·00092	− ·00147	− ·00084	− ·00119
20 19 ...	− ·00124	− ·00137	− ·00124	− ·00174	− ·00154	− ·00125	− ·00154	− ·00150	− ·00121	− ·00109	− ·00126	− ·00092	− ·00132
21 19 ...	− ·00145	− ·00186	− ·00166	− ·00178	− ·00158	− ·00125	− ·00138	− ·00146	− ·00142	− ·00126	− ·00126	− ·00113	− ·00145
22 19 ..	− ·00136	− ·00207	− ·00162	− ·00191	− ·00141	− ·00117	− ·00117	− ·00159	− ·00126	− ·00109	− ·00126	− ·00122	− ·00143
23 19 ...	− ·00116	− ·00219	− ·00145	− ·00158	− ·00150	− ·00108	− ·00117	− ·00134	− ·00113	− ·00071	− ·00122	− ·00109	− ·00130
0 19 ..	− ·00116	− ·00215	− ·00149	− ·00133	− ·00137	− ·00117	− ·00125	− ·00125	− ·00109	− ·00038	− ·00105	− ·00059	− ·00119
1 19 ...	− ·00079	− ·00166	− ·00124	− ·00129	− ·00125	− ·00133	− ·00100	− ·00104	− ·00100	− ·00067	− ·00084	− ·00084	− ·00108
2 19 ...	− ·00112	− ·00149	− ·00133	− ·00112	− ·00108	− ·00125	− ·00108	− ·00088	− ·00079	− ·00080	− ·00071	− ·00101	− ·00105
3 19 ...	− ·00091	− ·00108	− ·00124	− ·00120	− ·00116	− ·00121	− ·00092	− ·00071	− ·00067	− ·00046	− ·00067	− ·00088	− ·00093
4 19 ...	− ·00074	− ·00091	− ·00112	− ·00091	− ·00104	− ·00117	− ·00083	− ·00075	− ·00059	− ·00059	− ·00067	− ·00080	− ·00084
5 19 ..	− ·00054	− ·00087	− ·00112	− ·00079	− ·00104	− ·00100	− ·00088	− ·00071	− ·00046	− ·00059	− ·00050	− ·00063	− ·00076
6 19 ...	− ·00025	− ·00054	− ·00083	− ·00075	− ·00066	− ·00062	− ·00058	− ·00058	− ·00075	− ·00059	− ·00034	− ·00038	− ·00057
7 19 ...	+ ·00017	+ ·00004	− ·00029	− ·00004	+ ·00004	·00000	− ·00013	− ·00038	− ·00092	− ·00029	+ ·00029	+ ·00021	− ·00011
8 19 ...	+ ·00099	+ ·00120	+ ·00099	+ ·00120	+ ·00091	+ ·00079	+ ·00029	+ ·00042	− ·00025	+ ·00059	+ ·00117	+ ·00088	+ ·00076
9 19 ...	+ ·00190	+ ·00244	+ ·00265	+ ·00286	+ ·00216	+ ·00191	+ ·00129	+ ·00171	+ ·00130	+ ·00155	+ ·00193	+ ·00172	+ ·00195
Average progressive increase *per* day ...	− ·00016	− ·00005	− ·00013	− ·00017	− ·00016	− ·00022	− ·00027	·00000	− ·00026	− ·00011	− ·00026	− ·00005	− ·00015

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TABLE 140.—HORIZONTAL FORCE MAGNETOGRAPH.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1875 *and for the whole year.*

1875. Bombay Civil Time.			MONTH.											Year.
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.	m.														
10	19	...	+·00193	+·00265	+·00358	+·00397	+·00292	+·00305	+·00229	+·00234	+·00204	+·00251	+·00269	+·00196	+·00266
11	19	...	+·00227	+·00337	+·00392	+·00418	+·00304	+·00305	+·00263	+·00272	+·00217	+·00277	+·00264	+·00201	+·00290
12	19	...	+·00189	+·00303	+·00333	+·00333	+·00266	+·00271	+·00254	+·00255	+·00208	+·00226	+·00196	+·00167	+·00250
13	19	...	+·00139	+·00227	+·00207	+·00236	+·00190	+·00207	+·00204	+·00200	+·00149	+·00132	+·00102	+·00111	+·00175
14	19	...	+·00080	+·00114	+·00084	+·00114	+·00101	+·00123	+·00127	+·00119	+·00068	+·00043	+·00034	+·00047	+·00088
15	19	...	+·00017	+·00029	−·00017	+·00021	+·00025	+·00017	+·00021	+·00042	−·00004	−·00034	−·00021	−·00004	+·00008
16	19	...	−·00029	−·00055	−·00093	−·00046	−·00038	−·00068	−·00042	−·00025	−·00055	−·00081	−·00073	−·00038	−·00054
17	19	...	−·00063	−·00109	−·00122	−·00110	−·00093	−·00106	−·00085	−·00059	−·00081	−·00094	−·00085	−·00064	−·00089
18	19	...	−·00067	−·00147	−·00114	−·00127	−·00101	−·00131	−·00106	−·00089	−·00094	−·00089	−·00090	−·00056	−·00101
19	19	...	−·00088	−·00135	−·00135	−·00139	−·00114	−·00123	−·00115	−·00098	−·00094	−·00094	−·00094	−·00051	−·00107
20	19	...	−·00092	−·00147	−·00148	−·00143	−·00114	−·00118	−·00119	−·00102	−·00102	−·00098	−·00107	−·00085	−·00115
21	19	...	−·00097	−·00143	−·00156	−·00160	−·00123	−·00114	−·00123	−·00098	−·00115	−·00089	−·00102	−·00085	−·00117
22	19	...	−·00092	−·00143	−·00148	−·00148	−·00123	−·00114	−·00123	−·00081	−·00094	−·00098	−·00111	−·00085	−·00113
23	19	...	−·00101	−·00109	−·00148	−·00152	−·00118	−·00106	−·00110	−·00106	−·00072	−·00068	−·00085	−·00081	−·00105
0	19	...	−·00105	−·00105	−·00131	−·00160	−·00127	−·00106	−·00102	−·00098	−·00064	−·00072	−·00081	−·00090	−·00103
1	19	...	−·00084	−·00084	−·00122	−·00152	−·00106	−·00093	−·00098	−·00093	−·00038	−·00072	−·00085	−·00073	−·00092
2	19	...	−·00097	−·00076	−·00110	−·00127	−·00106	−·00093	−·00093	−·00093	−·00043	−·00072	−·00077	−·00081	−·00089
3	19	...	−·00071	−·00072	−·00089	−·00114	−·00093	−·00097	−·00085	−·00089	−·00017	−·00072	−·00073	−·00073	−·00079
4	19	...	−·00063	−·00067	−·00072	−·00105	−·00089	−·00097	−·00076	−·00085	−·00021	−·00068	−·00064	−·00068	−·00073
5	19	...	−·00042	−·00059	−·00059	−·00089	−·00076	−·00089	−·00059	−·00085	−·00009	−·00055	−·00047	−·00051	−·00060
6	19	...	−·00017	−·00051	−·00051	−·00080	−·00051	−·00047	−·00025	−·00064	−·00030	−·00043	−·00026	−·00021	−·00042
7	19	...	+·00017	−·00034	−·00004	−·00046	−·00008	+·00017	+·00017	−·00038	−·00047	−·00004	+·00038	+·00026	−·00005
8	19	...	+·00084	+·00046	+·00122	+·00084	+·00089	+·00093	+·00076	+·00042	−·00004	+·00089	+·00119	+·00102	+·00078
9	19	...	+·00135	+·00160	+·00266	+·00262	+·00186	+·00199	+·00136	+·00149	+·00119	+·00196	+·00200	+·00137	+·00179
Average progressive increase *per* day		...	−·00011	−·00033	−·00002	−·00015	−·00021	−·00025	−·00022	−·00015	−·00022	−·00013	−·00019	−·00007	−·00017

TABLE 141.—HORIZONTAL FORCE MAGNETOGRAPH.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1876 *and for the whole year.*

1876. Bombay Civil Time.			MONTH.											Year.
h.	m.		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
10	19	...	+ ·00231	+ ·00261	+ ·00334	+ ·00317	+ ·00292	+ ·00232	+ ·00267	+ ·00220	+ ·00181	+ ·00220	+ ·00272	+ ·00212	+ ·00253
11	19	...	+ ·00269	+ ·00282	+ ·00364	+ ·00339	+ ·00292	+ ·00249	+ ·00305	+ ·00246	+ ·00207	+ ·00272	+ ·00268	+ ·00216	+ ·00276
12	19	...	+ ·00227	+ ·00244	+ ·00317	+ ·00291	+ ·00240	+ ·00241	+ ·00267	+ ·00237	+ ·00190	+ ·00238	+ ·00225	+ ·00177	+ ·00241
13	19	...	+ ·00150	+ ·00128	+ ·00210	+ ·00214	+ ·00172	+ ·00189	+ ·00206	+ ·00198	+ ·00142	+ ·00134	+ ·00134	+ ·00108	+ ·00165
14	19	...	+ ·00090	+ ·00056	+ ·00111	+ ·00124	+ ·00082	+ ·00120	+ ·00125	+ ·00121	+ ·00086	+ ·00052	+ ·00052	+ ·00048	+ ·00089
15	19	...	+ ·00030	− ·00009	+ ·00017	+ ·00056	·00000	+ ·00030	+ ·00030	+ ·00030	+ ·00017	− ·00013	− ·00030	− ·00004	+ ·00013
16	19	...	− ·00013	− ·00073	− ·00034	− ·00009	− ·00060	− ·00034	− ·00047	− ·00030	− ·00022	− ·00039	− ·00091	− ·00039	− ·00041
17	19	...	− ·00056	− ·00077	− ·00069	− ·00060	− ·00090	− ·00090	− ·00086	− ·00069	− ·00043	− ·00060	− ·00108	− ·00087	− ·00075
18	19	...	− ·00073	− ·00081	− ·00103	− ·00094	− ·00116	− ·00120	− ·00112	− ·00103	− ·00060	− ·00073	− ·00112	− ·00095	− ·00095
19	19	...	− ·00085	− ·00090	− ·00124	− ·00120	− ·00116	− ·00107	− ·00125	− ·00108	− ·00065	− ·00099	− ·00112	− ·00095	− ·00104
20	19	...	− ·00107	− ·00098	− ·00133	− ·00141	− ·00116	− ·00112	− ·00125	− ·00108	− ·00082	− ·00112	− ·00117	− ·00100	− ·00113
21	19	...	− ·00137	− ·00107	− ·00154	− ·00141	− ·00112	− ·00112	− ·00112	− ·00103	− ·00078	− ·00117	− ·00117	− ·00100	− ·00116
22	19	...	− ·00124	− ·00111	− ·00154	− ·00124	− ·00116	− ·00103	− ·00103	− ·00099	− ·00069	− ·00104	− ·00104	− ·00087	− ·00108
23	19	...	− ·00120	− ·00107	− ·00128	− ·00111	− ·00107	− ·00095	− ·00103	− ·00078	− ·00069	− ·00078	− ·00086	− ·00078	− ·00097
0	19	...	− ·00111	− ·00098	− ·00133	− ·00111	− ·00103	− ·00077	− ·00090	− ·00073	− ·00065	− ·00069	− ·00086	− ·00087	− ·00092
1	19	...	− ·00094	− ·00094	− ·00137	− ·00120	− ·00090	− ·00073	− ·00099	− ·00078	− ·00056	− ·00052	− ·00073	− ·00056	− ·00085
2	19	...	− ·00081	− ·00077	− ·00120	− ·00116	− ·00099	− ·00073	− ·00099	− ·00078	− ·00035	− ·00052	− ·00069	− ·00052	− ·00079
3	19	...	− ·00077	− ·00064	− ·00103	− ·00107	− ·00090	− ·00077	− ·00095	− ·00060	− ·00047	− ·00060	− ·00065	− ·00061	− ·00075
4	19	...	− ·00064	− ·00064	− ·00098	− ·00103	− ·00086	− ·00069	− ·00099	− ·00073	− ·00047	− ·00052	− ·00052	− ·00056	− ·00072
5	19	...	− ·00056	− ·00051	− ·00086	− ·00099	− ·00077	− ·00077	− ·00095	− ·00078	− ·00043	− ·00043	− ·00043	− ·00043	− ·00066
6	19	...	− ·00026	− ·00039	− ·00081	− ·00090	− ·00056	− ·00039	− ·00060	− ·00073	− ·00052	− ·00035	− ·00013	− ·00017	− ·00048
7	19	...	+ ·00013	·00000	− ·00039	− ·00051	+ ·00009	+ ·00017	+ ·00009	− ·00026	− ·00065	− ·00013	+ ·00043	+ ·00035	− ·00006
8	19	...	+ ·00064	+ ·00077	+ ·00081	+ ·00056	+ ·00120	+ ·00073	+ ·00086	+ ·00047	− ·00026	+ ·00048	+ ·00121	+ ·00091	+ ·00070
9	19	...	+ ·00137	+ ·00175	+ ·00214	+ ·00206	+ ·00215	+ ·00142	+ ·00189	+ ·00146	+ ·00091	+ ·00121	+ ·00199	+ ·00151	+ ·00165
Average progressive increase *per* day		...	− ·00014	− ·00008	− ·00020	− ·00010	− ·00013	− ·00022	— ·00011	− ·00019	− ·00015	− ·00015	− ·00008	− ·00011	− ·00014

Table 142.—Horizontal Force Magnetograph.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1877 *and for the whole year.*

1877. Bombay Civil Time.			MONTH.											Year.
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.	m.														
10	19	...	+ ·00221	+ ·00204	+ ·00278	+ ·00303	+ ·00242	+ ·00234	+ ·00238	+ ·00202	+ ·00202	+ ·00256	+ ·00211	+ ·00194	+ ·00232
11	19	...	+ ·00251	+ ·00242	+ ·00327	+ ·00340	+ ·00287	+ ·00242	+ ·00279	+ ·00247	+ ·00235	+ ·00301	+ ·00211	+ ·00207	+ ·00264
12	19	...	+ ·00212	+ ·00225	+ ·00266	+ ·00274	+ ·00246	+ ·00209	+ ·00267	+ ·00239	+ ·00210	+ ·00264	+ ·00157	+ ·00169	+ ·00228
13	19	...	+ ·00117	+ ·00156	+ ·00180	+ ·00160	+ ·00184	+ ·00156	+ ·00201	+ ·00189	+ ·00157	+ ·00153	+ ·00074	+ ·00091	+ ·00151
14	19	...	+ ·00039	+ ·00089	+ ·00074	+ ·00078	+ ·00098	+ ·00070	+ ·00099	+ ·00111	+ ·00095	+ ·00054	+ ·00017	+ ·00041	+ ·00072
15	19	...	− ·00009	+ ·00029	− ·00020	+ ·00008	+ ·00012	− ·00008	+ ·00008	+ ·00029	+ ·00033	− ·00012	− ·00029	+ ·00012	+ ·00004
16	19	...	− ·00030	− ·00031	− ·00061	− ·00029	− ·00041	− ·00070	− ·00066	− ·00045	− ·00025	− ·00049	− ·00066	− ·00017	− ·00044
17	19	...	− ·00052	− ·00061	− ·00074	− ·00053	− ·00086	− ·00098	− ·00099	− ·00082	− ·00049	− ·00087	− ·00087	− ·00045	− ·00073
18	19	...	− ·00069	− ·00074	− ·00078	− ·00090	− ·00123	− ·00135	− ·00103	− ·00103	− ·00066	− ·00111	− ·00087	− ·00062	− ·00092
19	19	...	− ·00069	− ·00103	− ·00090	− ·00123	− ·00107	− ·00123	− ·00094	− ·00095	− ·00082	− ·00103	− ·00095	− ·00087	− ·00098
20	19	...	− ·00074	− ·00106	− ·00119	− ·00131	− ·00119	− ·00119	− ·00090	− ·00095	− ·00082	− ·00103	− ·00062	− ·00099	− ·00100
21	19	...	− ·00087	− ·00112	− ·00123	− ·00127	− ·00098	− ·00115	− ·00082	− ·00107	− ·00095	− ·00115	− ·00074	− ·00095	− ·00102
22	19	...	− ·00104	− ·00102	− ·00123	− ·00131	− ·00111	− ·00103	− ·00086	− ·00099	− ·00082	− ·00120	− ·00083	− ·00070	− ·00101
23	19	...	− ·00095	− ·00093	− ·00110	− ·00098	− ·00102	− ·00082	− ·00094	− ·00074	− ·00082	− ·00099	− ·00099	− ·00087	− ·00093
0	19	...	− ·00091	− ·00089	− ·00094	− ·00086	− ·00082	− ·00070	− ·00086	− ·00082	− ·00066	− ·00091	− ·00091	− ·00079	− ·00084
1	19	...	− ·00087	− ·00068	− ·00069	− ·00082	− ·00078	− ·00066	− ·00099	− ·00086	− ·00070	− ·00087	− ·00070	− ·00070	− ·00078
2	19	...	− ·00091	− ·00075	− ·00061	− ·00074	− ·00078	− ·00053	− ·00094	− ·00078	− ·00062	− ·00074	− ·00062	− ·00066	− ·00072
3	19	...	− ·00074	− ·00059	− ·00061	− ·00074	− ·00057	− ·00045	− ·00082	− ·00082	− ·00054	− ·00066	− ·00045	− ·00050	− ·00062
4	19	...	− ·00052	− ·00051	− ·00057	− ·00078	− ·00049	− ·00057	− ·00078	− ·00078	− ·00049	− ·00070	− ·00050	− ·00041	− ·00059
5	19	...	− ·00048	− ·00045	− ·00053	− ·00090	− ·00066	− ·00057	− ·00074	− ·00066	− ·00041	− ·00058	− ·00021	− ·00037	− ·00055
6	19	...	− ·00026	− ·00040	− ·00061	− ·00086	− ·00066	− ·00021	− ·00053	− ·00049	− ·00062	− ·00058	− ·00008	− ·00012	− ·00045
7	19	...	+ ·00013	− ·00007	− ·00025	− ·00041	− ·00020	+ ·00053	− ·00008	− ·00029	− ·00066	− ·00021	+ ·00041	+ ·00021	− ·00007
8	19	...	+ ·00078	+ ·00044	+ ·00053	+ ·00049	+ ·00061	+ ·00123	+ ·00066	+ ·00053	·00000	+ ·00066	+ ·00111	+ ·00074	+ ·00065
9	19	...	+ ·00152	+ ·00127	+ ·00159	+ ·00184	+ ·00156	+ ·00185	+ ·00140	+ ·00140	+ ·00111	+ ·00177	+ ·00161	+ ·00132	+ ·00152
Average progressive increase *per* day		...	− ·00011	·00000	− ·00010	− ·00012	− ·00022	− ·00006	− ·00013	− ·00011	− ·00012	− ·00003	− ·00014	− ·00010	− ·00010

TABLE 143.—HORIZONTAL FORCE MAGNETOGRAPH.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1878 *and for the whole year.*

1878.	MONTH.												Year.
Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 19 ...	+ ·00153	+ ·00186	+ ·00294	+ ·00315	+ ·00241	+ ·00266	+ ·00208	+ ·00179	+ ·00187	+ ·00225	+ ·00267	+ ·00184	+ ·00225
11 19 ...	+ ·00157	+ ·00228	+ ·00331	+ ·00315	+ ·00278	+ ·00283	+ ·00249	+ ·00229	+ ·00229	+ ·00254	+ ·00280	+ ·00205	+ ·00253
12 19 ...	+ ·00116	+ ·00211	+ ·00282	+ ·00269	+ ·00237	+ ·00249	+ ·00241	+ ·00254	+ ·00221	+ ·00200	+ ·00213	+ ·00171	+ ·00222
13 19 ...	+ ·00074	+ ·00157	+ ·00182	+ ·00195	+ ·00166	+ ·00175	+ ·00204	+ ·00216	+ ·00162	+ ·00129	+ ·00104	+ ·00104	+ ·00156
14 19 ...	+ ·00037	+ ·00087	+ ·00079	+ ·00095	+ ·00079	+ ·00083	+ ·00121	+ ·00146	+ ·00075	+ ·00046	+ ·00025	+ ·00046	+ ·00077
15 19 ...	+ ·00021	+ ·00033	- ·00004	+ ·00021	+ ·00008	+ ·00004	+ ·00025	+ ·00071	- ·00004	·00000	- ·00021	+ ·00004	+ ·00013
16 19 ...	·00000	- ·00012	- ·00041	- ·00046	- ·00046	- ·00071	- ·00046	- ·00004	- ·00050	- ·00025	- ·00050	- ·00029	- ·00035
17 19 ...	- ·00029	- ·00041	- ·00058	- ·00070	- ·00071	- ·00100	- ·00079	- ·00050	- ·00067	- ·00042	- ·00079	- ·00067	- ·00063
18 19 ...	- ·00041	- ·00070	- ·00091	- ·00100	- ·00087	- ·00100	- ·00095	- ·00067	- ·00079	- ·00071	- ·00100	- ·00075	- ·00081
19 19 ...	- ·00050	- ·00083	- ·00108	- ·00120	- ·00100	- ·00100	- ·00100	- ·00087	- ·00071	- ·00092	- ·00121	- ·00088	- ·00093
20 19 ...	- ·00062	- ·00095	- ·00116	- ·00133	- ·00100	- ·00120	- ·00087	- ·00104	- ·00071	- ·00104	- ·00125	- ·00100	- ·00101
21 19 ...	- ·00070	- ·00108	- ·00120	- ·00149	- ·00100	- ·00100	- ·00087	- ·00112	- ·00087	- ·00104	- ·00134	- ·00079	- ·00104
22 19 ...	- ·00079	- ·00099	- ·00124	- ·00137	- ·00100	- ·00108	- ·00083	- ·00104	- ·00083	- ·00096	- ·00117	- ·00079	- ·00101
23 19 ...	- ·00083	- ·00099	- ·00128	- ·00116	- ·00091	- ·00096	- ·00079	- ·00092	- ·00079	- ·00096	- ·00092	- ·00079	- ·00094
0 19 ...	- ·00074	- ·00087	- ·00112	- ·00120	- ·00108	- ·00100	- ·00079	- ·00079	- ·00071	- ·00079	- ·00083	- ·00067	- ·00088
1 19 ...	- ·00066	- ·00075	- ·00108	- ·00129	- ·00100	- ·00079	- ·00079	- ·00079	- ·00062	- ·00075	- ·00075	- ·00075	- ·00083
2 19 ...	- ·00062	- ·00079	- ·00099	- ·00120	- ·00087	- ·00087	- ·00075	- ·00075	- ·00042	- ·00075	- ·00083	- ·00067	- ·00078
3 19 ...	- ·00054	- ·00070	- ·00099	- ·00091	- ·00087	- ·00087	- ·00075	- ·00075	- ·00033	- ·00067	- ·00070	- ·00054	- ·00072
4 19 ...	- ·00041	- ·00066	- ·00083	- ·00083	- ·00083	- ·00096	- ·00071	- ·00071	- ·00029	- ·00063	- ·00063	- ·00038	- ·00066
5 19 ...	- ·00017	- ·00058	- ·00083	- ·00091	- ·00066	- ·00083	- ·00075	- ·00071	- ·00025	- ·00063	- ·00058	- ·00033	- ·00060
6 19 ...	·00000	- ·00046	- ·00070	- ·00070	- ·00050	- ·00046	- ·00067	- ·00062	- ·00046	- ·00058	- ·00029	- ·00021	- ·00047
7 19 ...	+ ·00021	·00000	- ·00012	- ·00012	+ ·00017	+ ·00025	- ·00029	- ·00050	- ·00050	- ·00008	+ ·00042	+ ·00017	- ·00003
8 19 ...	+ ·00058	+ ·00066	+ ·00104	+ ·00100	+ ·00091	+ ·00112	+ ·00029	·00000	+ ·00008	+ ·00083	+ ·00129	+ ·00063	+ ·00070
9 19 ...	+ ·00108	+ ·00153	+ ·00228	+ ·00232	+ ·00170	+ ·00195	+ ·00125	+ ·00092	+ ·00100	+ ·00183	+ ·00209	+ ·00129	+ ·00160
Average progressive increase *per* day ...	- ·00008	- ·00009	- ·00007	- ·00011	- ·00012	- ·00008	- ·00010	- ·00015	- ·00010	- ·00005	- ·00013	- ·00007	- ·00010

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Table 144.—Horizontal Force Magnetograph.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1879 and for the whole year.

1879. Bombay Civil Time.	MONTH. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 19 ...	+ ·00113	+ ·00222	+ ·00297	+ ·00314	+ ·00268	+ ·00268	+ ·00235	+ ·00227	+ ·00227	+ ·00252	+ ·00257	+ ·00248	+ ·00244
11 19 ...	+ ·00167	+ ·00242	+ ·00343	+ ·00327	+ ·00289	+ ·00272	+ ·00268	+ ·00243	+ ·00261	+ ·00290	+ ·00261	+ ·00244	+ ·00267
12 19 ...	+ ·00167	+ ·00230	+ ·00297	+ ·00280	+ ·00239	+ ·00247	+ ·00256	+ ·00222	+ ·00244	+ ·00244	+ ·00194	+ ·00185	+ ·00234
13 19 ...	+ ·00109	+ ·00151	+ ·00205	+ ·00193	+ ·00189	+ ·00189	+ ·00197	+ ·00168	+ ·00189	+ ·00143	+ ·00093	+ ·00118	+ ·00162
14 19 ...	+ ·00054	+ ·00063	+ ·00100	+ ·00092	+ ·00096	+ ·00080	+ ·00126	+ ·00088	+ ·00088	+ ·00055	+ ·00021	+ ·00046	+ ·00076
15 19 ...	+ ·00021	·00000	+ ·00038	+ ·00021	+ ·00013	+ ·00013	+ ·00034	− ·00004	+ ·00017	− ·00004	− ·00025	+ ·00008	+ ·00011
16 19 ..	− ·00004	− ·00046	− ·00038	− ·00033	− ·00054	− ·00059	− ·00034	− ·00059	− ·00029	− ·00042	− ·00055	− ·00025	− ·00040
17 19 ...	− ·00021	− ·00059	− ·00079	− ·00063	− ·00092	− ·00096	− ·00080	− ·00063	− ·00050	− ·00059	− ·00063	− ·00038	− ·00064
18 19 ...	− ·00029	− ·00075	− ·00100	− ·00096	− ·00117	− ·00122	− ·00109	− ·00076	− ·00076	− ·00084	− ·00080	− ·00059	− ·00085
19 19 ...	− ·00042	− ·00079	− ·00105	− ·00121	− ·00121	− ·00117	− ·00113	− ·00084	− ·00084	− ·00092	− ·00097	− ·00076	− ·00094
20 19 ...	− ·00046	− ·00088	− ·00130	− ·00126	− ·00126	− ·00117	− ·00109	− ·00088	− ·00097	− ·00105	− ·00105	− ·00105	− ·00103
21 19 ...	− ·00071	− ·00100	− ·00138	− ·00126	− ·00126	− ·00109	− ·00109	− ·00092	− ·00101	− ·00118	− ·00109	− ·00122	− ·00110
22 19 ...	− ·00088	− ·00113	− ·00130	− ·00121	− ·00109	− ·00101	− ·00113	− ·00092	− ·00109	− ·00109	− ·00114	− ·00122	− ·00110
23 19 ...	− ·00079	− ·00109	− ·00138	− ·00105	− ·00101	− ·00084	− ·00096	− ·00080	− ·00084	− ·00097	− ·00093	− ·00101	− ·00097
0 19 ...	− ·00075	− ·00105	− ·00121	− ·00100	− ·00088	− ·00080	− ·00101	− ·00080	− ·00084	− ·00071	− ·00088	− ·00109	− ·00092
1 19 ...	− ·00058	− ·00100	− ·00105	− ·00105	− ·00088	− ·00080	− ·00092	− ·00084	− ·00080	− ·00084	− ·00076	− ·00097	− ·00087
2 19 ...	− ·00063	− ·00088	− ·00105	− ·00096	− ·00096	− ·00075	− ·00092	− ·00080	− ·00071	− ·00084	− ·00072	− ·00101	− ·00085
3 19 ...	− ·00054	− ·00075	− ·00100	− ·00096	− ·00084	− ·00084	− ·00088	− ·00076	− ·00055	− ·00076	− ·00067	− ·00084	− ·00078
4 19 ...	− ·00038	− ·00067	− ·00088	− ·00092	− ·00075	− ·00088	− ·00084	− ·00067	− ·00046	− ·00067	− ·00059	− ·00072	− ·00070
5 19 ...	− ·00025	− ·00050	− ·00088	− ·00092	− ·00071	− ·00080	− ·00080	− ·00059	− ·00046	− ·00067	− ·00050	− ·00046	− ·00063
6 19 ...	− ·00013	+ ·00033	− ·00075	− ·00084	− ·00050	− ·00038	− ·00050	− ·00050	− ·00050	− ·00063	− ·00029	− ·00021	− ·00046
7 19 ...	− ·00008	+ ·00021	− ·00033	− ·00033	− ·00004	+ ·00025	+ ·00013	− ·00021	− ·00059	− ·00017	+ ·00038	+ ·00055	− ·00002
8 19 ...	+ ·00029	+ ·00100	+ ·00071	+ ·00071	+ ·00101	+ ·00096	+ ·00084	+ ·00050	− ·00004	+ ·00063	+ ·00135	+ ·00130	+ ·00077
9 19 ...	+ ·00063	+ ·00180	+ ·00201	+ ·00218	+ ·00193	+ ·00189	+ ·00164	+ ·00151	+ ·00122	+ ·00168	+ ·00206	+ ·00194	+ ·00171
Average progressive increase *per* day	·00000	− ·00013	− ·00009	− ·00006	− ·00012	− ·00003	− ·00005	− ·00011	− ·00001	− ·00011	− ·00002	− ·00005	− ·00006

Table 145.—Horizontal Force Magnetograph.

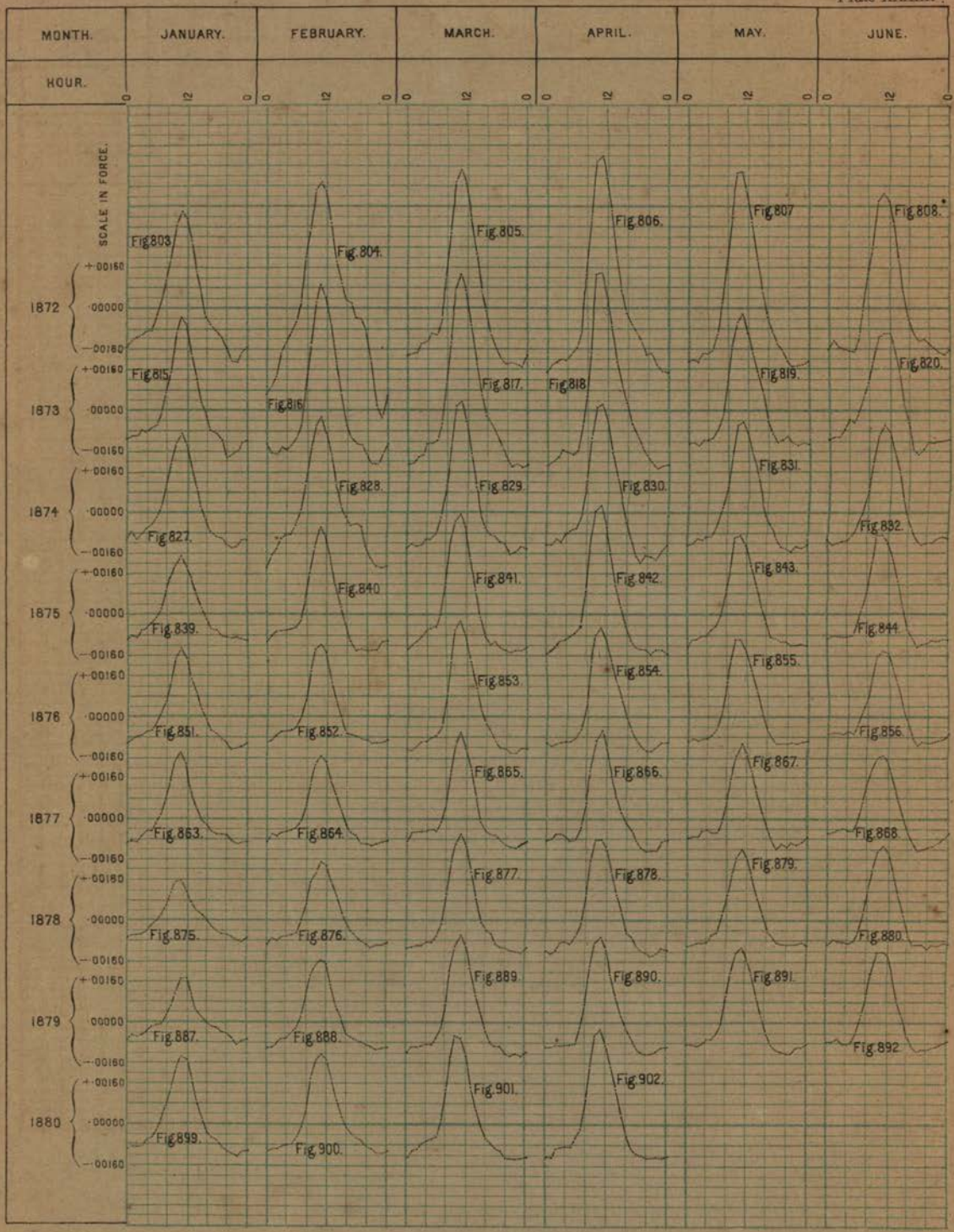
Showing the mean diurnal variation of Horizontal Force for the months January to April of the year 1880.

1880. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 19 ...	+·00215	+·00244	+·00342	+·00342									
11 19 ...	+·00265	+·00274	+·00329	+·00363									
12 19 ...	+·00249	+·00257	+·00266	+·00308									
13 19 ...	+·00173	+·00177	+·00148	+·00224									
14 19 ...	+·00084	+·00084	+·00046	+·00127									
15 19 ...	+·00017	+·00025	−·00004	+·00025									
16 19 ...	−·00038	−·00017	−·00067	−·00051									
17 19 ...	−·00055	−·00042	−·00080	−·00101									
18 19 ...	−·00072	−·00055	−·00093	−·00118									
19 19 ...	−·00093	−·00076	−·00114	−·00122									
20 19 ...	−·00114	−·00093	−·00135	−·00139									
21 19 ...	−·00118	−·00101	−·00139	−·00135									
22 19 ...	−·00126	−·00118	−·00139	−·00131									
23 19 ...	−·00114	−·00118	−·00131	−·00135									
0 19 ...	−·00105	−·00110	−·00127	−·00127									
1 19 ...	−·00088	−·00101	−·00110	−·00131									
2 19 ...	−·00088	−·00101	−·00105	−·00105									
3 19 ...	−·00084	−·00093	−·00080	−·00097									
4 19 ...	−·00072	−·00084	−·00076	−·00093									
5 19 ...	−·00059	−·00080	−·00067	−·00093									
6 19 ...	−·00034	−·00055	−·00055	−·00063									
7 19 ...	+·00013	−·00013	+·00008	−·00030									
8 19 ...	+·00072	+·00059	+·00127	+·00089									
9 19 ...	+·00135	+·00177	+·00266	+·00232									
Average progressive increase *per* day ...	−·00012	·00000	−·00005	−·00015									

COLABA OBSERVATORY.

HORIZONTAL FORCE MAGNETOGRAPH. DIURNAL VARIATION.

Plate XXXIII.



COLABA OBSERVATORY.

HORIZONTAL FORCE MAGNETOGRAPH. DIURNAL VARIATION.

Plate XXXIII *Continued.*

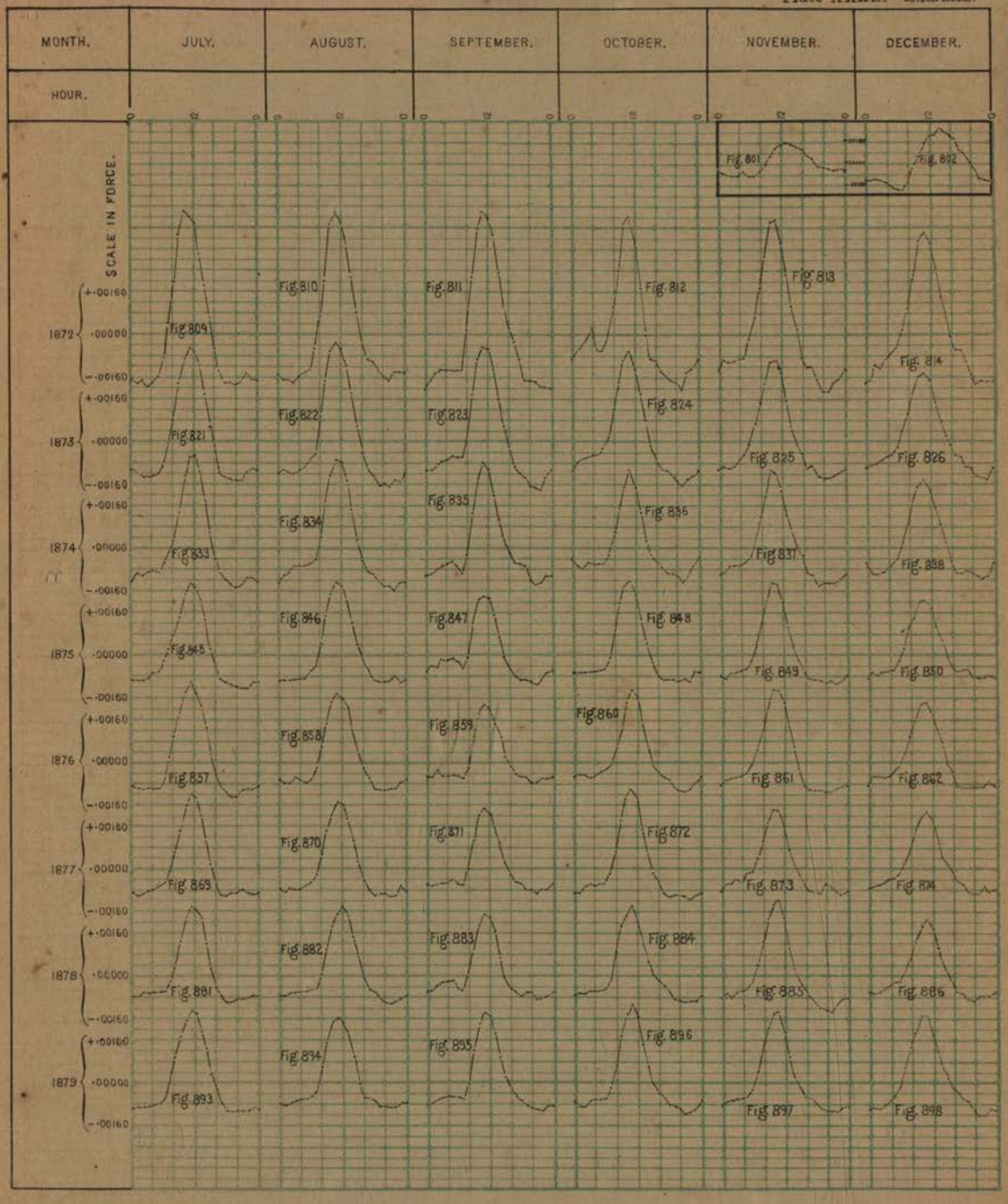


Table 146.—Vertical Force Magnetograph.

Showing the mean diurnal variation of Vertical Force for the months May to December of the year 1872.

1872. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...					−·00215	−·00165	−·00185	−·00154	−·00243	−·00177	−·00045	−·00051	
11 17 ...					−·00188	−·00160	−·00159	−·00146	−·00251	−·00173	−·00041	−·00042	
12 17 ...					−·00140	−·00109	−·00090	−·00105	−·00182	−·00103	+·00021	+·00008	
13 17 ...					−·00048	−·00042	−·00026	−·00045	−·00065	−·00021	+·00041	+·00051	
14 17 ...					+·00013	·00000	+·00043	−·00004	+·00028	+·00029	+·00025	+·00046	
15 17 ...					+·00053	+·00042	+·00069	+·00028	+·00061	+·00021	−·00008	+·00021	
16 17 ...					+·00053	+·00057	+·00069	+·00040	+·00049	−·00021	−·00029	−·00008	
17 17 ...					+·00018	+·00052	+·00052	+·00024	·00000	−·00049	−·00041	−·00042	
18 17 ...					+·00004	+·00019	+·00013	−·00012	+·00008	+·00008	−·00004	−·00004	
19 17 ...					+·00026	+·00005	−·00004	−·00016	+·00032	+·00025	−·00008	−·00004	
20 17 ...					+·00039	+·00009	+·00004	−·00004	+·00032	+·00016	−·00004	−·00013	
21 17 ...					+·00044	+·00019	+·00013	+·00004	+·00032	+·00016	−·00008	−·00013	
22 17 ...					+·00039	+·00024	+·00017	+·00008	+·00045	+·00049	+·00008	·00000	
23 17 ...					+·00044	+·00019	+·00022	+·00028	+·00053	+·00045	+·00012	+·00008	
0 17 ...					+·00044	+·00019	+·00022	+·00036	+·00057	+·00045	+·00012	+·00008	
1 17 ...					+·00044	+·00024	+·00026	+·00040	+·00061	+·00045	+·00012	+·00008	
2 17 ...					+·00044	+·00019	+·00022	+·00036	+·00057	+·00045	+·00012	+·00008	
3 17 ...					+·00039	+·00024	+·00026	+·00045	+·00061	+·00033	·00000	+·00004	
4 17 ...					+·00048	+·00028	+·00026	+·00040	+·00061	+·00045	−·00004	+·00004	
5 17 ...					+·00079	+·00052	+·00052	+·00069	+·00081	+·00045	−·00004	·00000	
6 17 ...					+·00114	+·00104	+·00095	+·00134	+·00146	+·00086	−·00004	+·00004	
7 17 ...					+·00053	+·00080	+·00069	+·00097	+·00097	+·00082	+·00025	+·00008	
8 17 ...					−·00053	−·00009	−·00026	−·00008	−·00036	−·00008	+·00037	+·00030	
9 17 ...					−·00171	−·00104	−·00120	−·00109	−·00162	−·00095	·00000	·00000	
Average progressive increase *per* day ...					−·00023	−·00007	+·00005	−·00016	−·00010	−·00006	−·00006	−·00003	

Table 147.—Vertical Force Magnetograph.

Showing the mean diurnal variation of Vertical Force for each month of the year 1873 *and for the whole year.*

1873. Bombay Civil Time.	MONTH. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00040	−·00109	−·00113	−·00148	−·00167	−·00155	−·00156	−·00165	−·00229	−·00142	−·00049	−·00030	−·00125
11 17 ...	−·00103	−·00084	−·00125	−·00162	−·00127	−·00140	−·00161	−·00138	−·00220	−·00129	−·00036	−·00056	−·00123
12 17 ...	−·00083	−·00020	−·00084	−·00097	−·00098	−·00140	−·00133	−·00107	−·00163	−·00058	+·00009	−·00034	−·00084
13 17 ...	−·00032	+·00036	+·00004	−·00023	−·00029	−·00075	−·00083	−·00062	−·00057	+·00013	+·00027	−·00021	−·00025
14 17 ...	−·00008	+·00064	+·00075	+·00042	+·00044	−·00040	−·00037	−·00013	+·00040	+·00053	·00000	−·00021	+·00017
15 17 ...	+·00020	+·00064	+·00071	+·00056	+·00073	−·00015	+·00005	+·00031	+·00075	+·00053	−·00022	−·00013	+·00033
16 17 ...	+·00051	+·00040	+·00017	+·00042	+·00073	−·00005	+·00028	+·00040	+·00053	·00000	−·00027	−·00004	+·00026
17 17 ...	+·00024	−·00004	−·00029	+·00005	+·00054	·00000	+·00018	+·00009	−·00004	−·00036	−·00018	−·00013	·00000
18 17 ..	+·00028	+·00004	−·00025	−·00014	+·00020	−·00010	−·00005	−·00027	−·00013	+·00013	·00000	+·00004	−·00002
19 17 ...	+·00032	+·00024	+·00021	+·00009	+·00024	−·00005	−·00018	−·00022	+·00009	+·00013	+·00004	+·00009	+·00008
20 17 ...	+·00016	+·00016	+·00025	+·00019	+·00029	+·00010	·00000	−·00009	+·00018	+·00013	·00000	+·00009	+·00012
21 17 ...	+·00012	+·00012	+·00008	+·00019	+·00034	+·00030	+·00018	+·00004	+·00022	+·00018	+·00004	+·00009	+·00016
22 17 ...	+·00020	+·00016	+·00017	+·00032	+·00039	+·00050	+·00037	+·00013	+·00035	+·00027	+·00009	+·00013	+·00026
23 17 ...	+·00016	+·00020	+·00029	+·00032	+·00039	+·00050	+·00041	+·00027	+·00044	+·00031	+·00018	+·00017	+·00030
0 17 ...	+·00012	+·00020	+·00029	+·00032	+·00034	+·00055	+·00051	+·00036	+·00053	+·00031	+·00018	+·00013	+·00032
1 17 ..	·00000	+·00016	+·00017	+·00028	+·00034	+·00050	+·00051	+·00040	+·00053	+·00031	+·00022	+·00013	+·00030
2 17 ...	·00000	+·00008	+·00013	+·00014	+·00020	+·00045	+·00051	+·00045	+·00053	+·00031	+·00018	+·00013	+·00026
3 17 ...	−·00012	·00000	+·00021	+·00005	+·00015	+·00025	+·00051	+·00049	+·00053	+·00022	+·00009	+·00009	+·00021
4 17 ...	−·00024	−·00008	+·00008	−·00005	+·00005	+·00045	+·00055	+·00054	+·00057	+·00018	+·00004	+·00009	+·00018
5 17 ...	−·00024	−·00012	+·00013	+·00005	+·00029	+·00075	+·00078	+·00080	+·00071	+·00022	·00000	+·00009	+·00029
6 17 ...	−·00024	−·00012	+·00938	+·00060	+·00059	+·00105	+·00115	+·00125	+·00119	+·00040	−·00009	+·00004	+·00052
7 17 ..	+·00020	+·00008	+·00046	+·00065	+·00010	+·00065	+·00092	+·00080	+·00079	+·00036	+·00009	+·00013	+·00044
8 17 ...	+·00059	−·00008	+·00004	+·00009	−·00083	+·00015	+·00014	−·00022	−·00053	−·00031	+·00013	+·00051	−·00003
9 17 ...	+·00051	−·00064	−·00071	−·00065	−·00171	−·00090	−·00106	−·00111	−·00123	−·00098	−·00004	+·00039	−·00068
Average progressive increase *per* day	+·00011	−·00014	−·00021	−·00022	−·00028	+·00007	+·00005	−·00006	−·00006	−·00002	+·00004	+·00004	−·00006

Table 148.—Vertical Force Magnetograph.

Showing the mean diurnal variation of Vertical Force for each month of the year 1874 and for the whole year.

1874. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00008	·00000	−·00085	−·00160	−·00176	−·00105	−·00173	−·00180	−·00224	−·00143	−·00082	−·00027	−·00114
11 17 ...	−·00067	−·00035	−·00126	−·00134	−·00181	−·00140	−·00183	−·00166	−·00211	−·00148	−·00068	−·00049	−·00126
12 17 ...	−·00064	−·00035	−·00105	−·00099	−·00148	−·00130	−·00135	−·00111	−·00169	−·00083	−·00023	−·00009	−·00093
13 17 ...	−·00052	−·00023	−·00045	−·00030	−·00081	−·00090	−·00091	−·00060	−·00073	·00000	·00000	+·00009	−·00045
14 17 ...	−·00040	−·00031	+·00012	+·00017	−·00010	−·00045	−·00024	−·00009	+·00018	+·00032	·00000	·00000	−·00007
15 17 ...	−·00028	−·00039	+·00024	+·00052	+·00033	−·00005	+·00024	+·00023	+·00064	+·00028	·00000	·00000	+·00015
16 17 ...	−·00008	−·00031	+·00068	+·00048	+·00043	+·00020	+·00043	+·00037	+·00060	+·00005	−·00009	+·00004	+·00018
17 17 ...	·00000	−·00027	−·00008	+·00017	+·00029	+·00020	+·00029	+·00014	+·00018	−·00028	−·00023	−·00018	+·00002
18 17 ...	+·00008	−·00008	−·00004	·00000	+·00010	+·00010	+·00005	−·00005	+·00014	·00000	·00000	−·00004	+·00002
19 17 ...	+·00024	+·00016	+·00016	+·00004	+·00005	−·00010	−·00019	−·00009	+·00023	+·00014	+·00005	+·00004	+·00006
20 17 ...	+·00024	+·00020	+·00024	+·00013	+·00024	+·00010	+·00005	+·00005	+·00032	+·00018	+·00009	·00000	+·00015
21 17 ...	+·00020	+·00016	+·00024	+·00026	+·00033	+·00020	+·00019	+·00018	+·00037	+·00018	+·00014	+·00004	+·00021
22 17 ...	+·00024	+·00020	+·00028	+·00030	+·00038	+·00030	+·00034	+·00032	+·00046	+·00028	+·00023	+·00009	+·00028
23 17 ...	+·00028	+·00023	+·00036	+·00035	+·00043	+·00035	+·00043	+·00037	+·00055	+·00042	+·00023	+·00013	+·00034
0 17 ...	+·00028	+·00020	+·00036	+·00030	+·00038	+·00040	+·00048	+·00046	+·00055	+·00037	+·00018	+·00009	+·00034
1 17 ...	+·00020	+·00016	+·00028	+·00030	+·00038	+·00040	+·00048	+·00051	+·00060	+·00042	+·00018	+·00013	+·00034
2 17 ..	+·00012	+·00012	+·00028	+·00026	+·00038	+·00035	+·00048	+·00051	+·00055	+·00037	+·00014	+·00009	+·00030
3 17 ...	+·00004	+·00008	+·00016	+·00022	+·00033	+·00030	+·00048	+·00046	+·00055	+·00032	+·00014	+·00009	+·00026
4 17 ...	+·00004	·00000	+·00012	+·00022	+·00033	+·00035	+·00048	+·00051	+·00060	+·00028	+·00014	+·00004	+·00026
5 17	·00000	−·00004	+·00016	+·00026	+·00057	+·00055	+·00072	+·00069	+·00069	+·00037	+·00009	+·00004	+·00034
6 17 ...	−·00004	−·00004	+·00028	+·00065	+·00100	+·00100	+·00106	+·00120	+·00128	+·00055	+·00005	·00000	+·00058
7 17 ...	·00000	+·00008	+·00045	+·00048	+·00071	+·00090	+·00072	+·00092	+·00092	+·00051	+·00023	+·00004	+·00050
8 17 ...	+·00040	+·00035	+·00020	−·00022	+·00005	+·00040	+·00014	−·00005	−·00041	−·00009	+·00023	+·00036	+·00011
9 17 ...	+·00044	+·00027	−·00028	−·00095	−·00109	−·00035	−·00077	−·00106	−·00169	−·00079	−·00018	+·00022	−·00052
Average progressive increase per day ...	+·00001	·00000	−·00008	−·00017	−·00022	+·00002	−·00002	−·00005	·00000	−·00002	−·00003	·00000	−·00005

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Table 149.—Vertical Force Magnetograph.

Showing the mean diurnal variation of Vertical Force for each month of the year 1875 *and for the whole year.*

1875.	MONTH.												Year.
Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 17 ...	− ·00142	− ·00080	− ·00054	− ·00121	− ·00160	− ·00141	− ·00119	− ·00166	− ·00234	− ·00140	− ·00087	− ·00024	− ·00122
11 17 ...	− ·00150	− ·00092	− ·00081	− ·00121	− ·00155	− ·00162	− ·00135	− ·00151	− ·00229	− ·00125	− ·00087	− ·00043	− ·00128
12 17 ...	− ·00064	− ·00029	− ·00081	− ·00087	− ·00103	− ·00130	− ·00104	− ·00095	− ·00161	− ·00063	− ·00034	− ·00019	− ·00081
13 17 ...	+ ·00013	+ ·00038	− ·00036	− ·00029	− ·00052	− ·00076	− ·00073	− ·00040	− ·00049	+ ·00014	+ ·00014	− ·00009	− ·00024
14 17 ...	+ ·00056	+ ·00063	+ ·00022	+ ·00034	+ ·00010	− ·00022	− ·00036	+ ·00005	+ ·00039	+ ·00053	+ ·00024	·00000	+ ·00021
15 17 ...	+ ·00069	+ ·00050	+ ·00040	+ ·00053	+ ·00047	+ ·00022	+ ·00005	+ ·00045	+ ·00073	+ ·00048	+ ·00019	− ·00005	+ ·00039
16 17 ...	+ ·00032	+ ·00013	+ ·00009	+ ·00048	+ ·00067	+ ·00032	+ ·00021	+ ·00055	+ ·00063	+ ·00014	+ ·00010	+ ·00009	+ ·00031
17 17 ...	− ·00017	− ·00029	− ·00027	+ ·00024	+ ·00041	+ ·00022	+ ·00016	+ ·00030	+ ·00024	− ·00019	− ·00005	+ ·00009	+ ·00006
18 17 ...	+ ·00009	− ·00008	− ·00036	− ·00010	+ ·00010	+ ·00005	+ ·00005	·00000	+ ·00005	− ·00005	+ ·00005	+ ·00009	− ·00001
19 17 ...	+ ·00021	+ ·00004	·00000	− ·00005	+ ·00005	+ ·00005	·00000	·00000	+ ·00020	+ ·00005	+ ·00010	+ ·00009	+ ·00006
20 17 ...	+ ·00021	+ ·00008	+ ·00009	+ ·00010	+ ·00016	+ ·00011	+ ·00005	+ ·00005	+ ·00024	+ ·00014	+ ·00014	+ ·00009	+ ·00012
21 17 ...	+ ·00026	+ ·00008	+ ·00009	+ ·00019	+ ·00026	+ ·00022	+ ·00016	+ ·00015	+ ·00034	+ ·00014	+ ·00010	+ ·00005	+ ·00017
22 17 ...	+ ·00026	+ ·00017	+ ·00013	+ ·00024	+ ·00031	+ ·00027	+ ·00026	+ ·00020	+ ·00044	+ ·00029	+ ·00019	+ ·00009	+ ·00024
23 17 ...	+ ·00021	+ ·00013	+ ·00022	+ ·00029	+ ·00026	+ ·00038	+ ·00031	+ ·00025	+ ·00054	+ ·00029	+ ·00024	+ ·00009	+ ·00027
0 17 ...	+ ·00026	+ ·00017	+ ·00022	+ ·00029	+ ·00031	+ ·00038	+ ·00031	+ ·00030	+ ·00049	+ ·00034	+ ·00024	+ ·00014	+ ·00029
1 17 ...	+ ·00017	+ ·00013	+ ·00018	+ ·00024	+ ·00026	+ ·00038	+ ·00042	+ ·00030	+ ·00054	+ ·00029	+ ·00019	+ ·00005	+ ·00026
2 17 ...	+ ·00017	+ ·00013	+ ·00013	+ ·00019	+ ·00026	+ ·00038	+ ·00042	+ ·00035	+ ·00049	+ ·00029	+ ·00019	+ ·00005	+ ·00025
3 17 ...	+ ·00017	+ ·00013	+ ·00009	+ ·00015	+ ·00021	+ ·00038	+ ·00042	+ ·00035	+ ·00054	+ ·00029	+ ·00014	·00000	+ ·00024
4 17 ...	+ ·00013	+ ·00008	+ ·00013	+ ·00015	+ ·00026	+ ·00038	+ ·00036	+ ·00035	+ ·00054	+ ·00029	+ ·00019	·00000	+ ·00024
5 17 ...	+ ·00009	·00000	+ ·00013	+ ·00015	+ ·00047	+ ·00054	+ ·00057	+ ·00050	+ ·00068	+ ·00024	+ ·00014	− ·00005	+ ·00029
6 17 ...	+ ·00009	+ ·00008	+ ·00018	+ ·00053	+ ·00088	+ ·00087	+ ·00088	+ ·00095	+ ·00107	+ ·00048	+ ·00010	− ·00014	+ ·00050
7 17 ...	+ ·00013	·00000	+ ·00036	+ ·00044	+ ·00052	+ ·00076	+ ·00078	+ ·00065	+ ·00073	+ ·00034	+ ·00019	− ·00009	+ ·00040
8 17 ...	+ ·00009	− ·00025	+ ·00018	− ·00034	− ·00036	+ ·00010	+ ·00031	− ·00020	− ·00054	− ·00039	+ ·00010	+ ·00009	− ·00010
9 17 ...	− ·00047	− ·00055	− ·00022	− ·00102	− ·00119	− ·00076	− ·00042	− ·00116	− ·00161	− ·00087	− ·00029	+ ·00005	− ·00070
Average progressive increase per day	+ ·00003	− ·00001	− ·00012	− ·00009	− ·00021	− ·00013	− ·00003	− ·00005	− ·00005	+ ·00004	+ ·00001	− ·00002	− ·00005

Table 150.—Vertical Force Magnetograph.

Showing the mean diurnal variation of Vertical Force for each month of the year 1876 *and for the whole year.*

1876. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00054	−·00081	−·00088	−·00127	−·00183	−·00172	−·00149	−·00213	−·00267	−·00206	−·00135	−·00044	−·00143
11 17 ...	−·00104	−·00094	−·00115	−·00127	−·00152	−·00182	−·00127	−·00188	−·00257	−·00211	−·00135	−·00063	−·00146
12 17 ...	−·00086	−·00049	−·00097	−·00083	−·00084	−·00145	−·00076	−·00147	−·00176	−·00120	−·00070	−·00034	−·00097
13 17 ...	−·00059	+·00004	−·00037	−·00022	−·00010	−·00070	−·00032	−·00086	−·00075	−·00010	−·00020	−·00020	−·00036
14 17 ...	−·00036	+·00045	+·00028	+·00026	+·00047	−·00016	+·00014	−·00020	+·00015	+·00060	·00000	−·00015	+·00012
15 17 ...	·00000	+·00049	+·00042	+·00044	+·00068	+·00038	+·00038	+·00025	+·00060	+·00070	+·00020	·00000	+·00038
16 17 ...	+·00018	+·00031	+·00018	+·00035	+·00058	+·00054	+·00040	+·00056	+·00055	+·00040	+·00025	+·00020	+·00037
17 17 ...	·00000	−·00004	−·00009	+·00013	+·00021	+·00038	+·00018	+·00035	+·00015	+·00010	+·00015	+·00005	+·00013
18 17 ...	+·00009	−·00004	−·00009	·00000	−·00005	+·00005	−·00008	·00000	+·00015	+·00025	+·00030	+·00015	+·00006
19 17 ...	+·00014	+·00004	·00000	+·00009	+·00005	·00000	−·00015	·00000	+·00015	+·00030	+·00030	+·00020	+·00009
20 17 ...	+·00018	+·00009	+·00009	+·00018	+·00016	+·00011	−·00003	+·00015	+·00030	+·00040	+·00040	+·00024	+·00019
21 17 ...	+·00018	+·00013	+·00009	+·00022	+·00021	+·00021	+·00007	+·00025	+·00035	+·00035	+·00035	+·00020	+·00022
22 17 ...	+·00018	+·00018	+·00018	+·00026	+·00031	+·00027	+·00020	+·00030	+·00045	+·00040	+·00035	+·00020	+·00027
23 17 ...	+·00023	+·00018	+·00028	+·00031	+·00031	+·00032	+·00026	+·00041	+·00050	+·00040	+·00030	+·00015	+·00030
0 17 ...	+·00023	+·00004	+·00032	+·00031	+·00037	+·00032	+·00036	+·00046	+·00055	+·00040	+·00030	+·00020	+·00032
1 17 ...	+·00023	+·00013	+·00023	+·00035	+·00037	+·00032	+·00033	+·00051	+·00055	+·00040	+·00025	+·00010	+·00031
2 17 ...	+·00018	+·00009	+·00023	+·00031	+·00037	+·00038	+·00037	+·00056	+·00060	+·00040	+·00020	+·00010	+·00032
3 17 ...	+·00018	+·00009	+·00018	+·00026	+·00031	+·00032	+·00038	+·00056	+·00060	+·00035	+·00015	+·00005	+·00029
4 17 ...	+·00014	+·00004	+·00018	+·00026	+·00031	+·00032	+·00041	+·00061	+·00065	+·00040	+·00015	+·00005	+·00029
5 17 ...	+·00009	·00000	+·00018	+·00026	+·00052	+·00059	+·00063	+·00081	+·00070	+·00035	+·00010	+·00005	+·00036
6 17 ...	+·00009	+·00004	+·00028	+·00057	+·00073	+·00096	+·00095	+·00122	+·00121	+·00055	·00000	−·00005	+·00055
7 17 ...	+·00018	+·00004	+·00037	+·00039	+·00042	+·00075	+·00058	+·00086	+·00096	+·00045	+·00015	−·00005	+·00042
8 17 ...	+·00059	·00000	+·00005	−·00018	−·00047	+·00005	−·00029	−·00015	−·00025	−·00025	+·00020	+·00024	−·00004
9 17 ...	+·00023	−·00040	−·00037	−·00079	−·00147	−·00080	−·00128	−·00137	−·00176	−·00115	−·00030	+·00015	−·00078
Average progressive increase *per* day ...	+·00003	+·00001	−·00002	−·00011	−·00012	−·00005	−·00021	+·00009	+·00001	+·00006	+·00002	+·00006	−·00002

Table 151.—Vertical Force Magnetograph

Showing the mean diurnal variation of Vertical Force for each month of the year 1877 *and for the whole year.*

1877. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00119	−·00107	−·00125	−·00181	−·00187	−·00180	−·00179	−·00236	−·00276	−·00157	−·00064	−·00145	−·00163
11 17 ...	−·00143	−·00130	−·00144	−·00211	−·00181	−·00197	−·00184	−·00220	−·00260	−·00146	−·00053	−·00124	−·00166
12 17 ...	−·00067	−·00079	−·00115	−·00156	−·00128	−·00135	−·00123	−·00137	−·00152	−·00060	−·00005	−·00047	−·00100
13 17 ...	−·00029	−·00023	−·00034	−·00050	−·00053	−·00045	−·00061	−·00060	−·00038	+·00016	+·00011	·00000	−·00030
14 17 ...	−·00010	+·00023	+·00053	+·00025	+·00027	+·00017	−·00006	+·00016	+·00054	+·00049	·00000	+·00016	+·00022
15 17 ...	+·00024	+·00033	+·00077	+·00070	+·00059	+·00039	+·00033	+·00071	+·00092	+·00049	·00000	+·00026	+·00048
16 17 ...	+·00033	+·00037	+·00058	+·00070	+·00064	+·00045	+·00039	+·00093	+·00087	+·00016	·00000	+·00026	+·00047
17 17 ...	+·00005	+·00005	+·00024	+·00030	+·00032	+·00022	+·00022	+·00055	+·00027	−·00011	+·00005	+·00010	+·00019
18 17 ...	+·00019	+·00014	+·00014	+·00025	+·00005	+·00006	−·00006	+·00005	+·00005	−·00005	+·00011	+·00021	+·00009
19 17 ...	+·00024	+·00028	+·00014	+·00025	+·00011	+·00006	·00000	+·00011	+·00022	−·00005	+·00011	+·00026	+·00014
20 17 ...	+·00024	+·00037	+·00029	+·00040	+·00021	+·00017	+·00011	+·00022	+·00027	+·00011	+·00016	+·00026	+·00023
21 17 ...	+·00024	+·00037	+·00024	+·00040	+·00027	+·00017	+·00017	+·00027	+·00038	+·00016	+·00016	+·00021	+·00025
22 17 ...	+·00024	+·00037	+·00019	+·00045	+·00032	+·00028	+·00028	+·00033	+·00038	+·00022	+·00016	+·00021	+·00029
23 17 ...	+·00019	+·00033	+·00019	+·00040	+·00037	+·00028	+·00028	+·00027	+·00038	+·00027	+·00016	+·00016	+·00027
0 17 ...	+·00024	+·00033	+·00024	+·00040	+·00043	+·00034	+·00028	+·00033	+·00038	+·00032	+·00011	+·00016	+·00030
1 17 ...	+·00019	+·00023	+·00019	+·00040	+·00043	+·00034	+·00028	+·00038	+·00038	+·00032	+·00011	+·00016	+·00028
2 17 ...	+·00014	+·00023	+·00019	+·00040	+·00043	+·00039	+·00033	+·00038	+·00043	+·00032	+·00005	+·00016	+·00029
3 17 ...	+·00010	+·00009	+·00014	+·00030	+·00037	+·00028	+·00033	+·00049	+·00043	+·00032	+·00005	+·00010	+·00025
4 17 ...	+·00010	+·00009	+·00010	+·00025	+·00043	+·00034	+·00039	+·00049	+·00049	+·00038	+·00005	+·00016	+·00027
5 17 ...	+·00005	+·00005	+·00010	+·00025	+·00064	+·00056	+·00061	+·00071	+·00060	+·00038	+·00005	+·00010	+·00034
6 17 ...	+·00005	+·00005	+·00019	+·00065	+·00091	+·00084	+·00106	+·00121	+·00108	+·00043	−·00005	+·00016	+·00055
7 17 ...	+·00019	+·00014	+·00024	+·00045	+·00053	+·00062	+·00084	+·00082	+·00081	+·00032	−·00005	+·00021	+·00043
8 17 ...	+·00057	·00000	−·00014	−·00040	−·00027	·00000	+·00006	−·00022	−·00038	−·00011	−·00005	+·00016	−·00006
9 17 ...	+·00014	−·00051	−·00063	−·00116	−·00133	−·00101	−·00061	−·00143	−·00173	−·00081	−·00016	−·00057	−·00082
Average progressive increase *per* day ...	+·00009	−·00005	−·00003	−·00017	−·00007	−·00003	+·00007	+·00009	−·00003	+·00005	+·00008	+·00007	+·00001

TABLE 152.—VERTICAL FORCE MAGNETOGRAPH.

Showing the mean diurnal variation of Vertical Force for each month of the year 1878 *and for the whole year.*

1878. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00140	−·00081	−·00133	−·00209	−·00170	−·00156	−·00170	−·00171	−·00241	−·00151	−·00048	−·00076	−·00145
11 17 ...	−·00159	−·00090	−·00143	−·00209	−·00159	−·00156	−·00176	−·00149	−·00230	−·00134	−·00048	−·00050	−·00142
12 17 ...	−·00092	−·00052	−·00104	−·00136	−·00115	−·00121	−·00132	−·00107	−·00166	−·00054	+·00011	+·00005	−·00089
13 17 ...	−·00029	+·00009	−·00015	−·00037	−·00038	−·00058	−·00082	−·00053	−·00079	+·00016	+·00016	+·00035	−·00025
14 17 ...	+·00010	+·00047	+·00064	+·00031	+·00022	−·00012	−·00011	·00000	+·00027	+·00059	·00000	+·00040	+·00023
15 17 ...	+·00039	+·00052	+·00084	+·00068	+·00038	+·00012	+·00033	+·00037	+·00070	+·00059	−·00011	+·00025	+·00042
16 17 ...	+·00048	+·00033	+·00059	+·00073	+·00044	+·00017	+·00044	+·00053	+·00059	+·00011	−·00016	+·00005	+·00036
17 17 ...	+·00034	+·00024	+·00020	+·00042	+·00027	·00000	+·00022	+·00021	+·00016	−·00022	−·00021	−·00005	+·00013
18 17 ...	+·00039	+·00019	+·00020	+·00026	+·00016	−·00006	+·00005	·00000	+·00005	·00000	−·00016	·00000	+·00009
19 17 ...	+·00039	+·00024	+·00020	+·00026	+·00022	·00000	−·00005	·00000	+·00021	+·00005	−·00016	−·00005	+·00011
20 17 ...	+·00043	+·00024	+·00025	+·00031	+·00022	+·00017	+·00011	+·00016	+·00032	+·00011	−·00016	−·00010	+·00017
21 17 ...	+·00034	+·00024	+·00020	+·00037	+·00027	+·00017	+·00022	+·00021	+·00037	+·00016	−·00011	−·00015	+·00019
22 17 ...	+·00029	+·00019	+·00020	+·00042	+·00033	+·00029	+·00033	+·00027	+·00037	+·00022	−·00005	−·00010	+·00023
23 17 ...	+·00024	+·00009	+·00020	+·00037	+·00033	+·00035	+·00033	+·00032	+·00043	+·00027	+·00005	−·00010	+·00024
0 17 ...	+·00019	+·00005	+·00015	+·00042	+·00033	+·00035	+·00044	+·00037	+·00048	+·00032	+·00011	−·00005	+·00026
1 17 ...	+·00005	+·00005	+·00015	+·00042	+·00027	+·00040	+·00038	+·00037	+·00048	+·00027	+·00011	−·00005	+·00024
2 17 ...	+·00005	−·00005	+·00015	+·00037	+·00022	+·00035	+·00038	+·00043	+·00048	+·00027	+·00016	·00000	+·00023
3 17 ...	·00000	−·00009	+·00010	+·00026	+·00022	+·00035	+·00038	+·00043	+·00053	+·00027	+·00011	·00000	+·00021
4 17 ...	·00000	−·00009	+·00005	+·00021	+·00016	+·00040	+·00044	+·00048	+·00053	+·00027	+·00016	+·00010	+·00023
5 17 ...	−·00005	−·00005	+·00005	+·00026	+·00033	+·00063	+·00066	+·00064	+·00064	+·00032	+·00016	+·00010	+·00031
6 17 ...	·00000	−·00005	+·00015	+·00057	+·00071	+·00092	+·00104	+·00101	+·00112	+·00048	+·00005	+·00015	+·00051
7 17 ...	+·00014	·00000	+·00025	+·00037	+·00060	+·00069	+·00082	+·00064	+·00080	+·00032	+·00021	+·00025	+·00042
8 17 ...	+·00029	−·00005	−·00015	−·00037	−·00005	+·00006	+·00016	−·00016	−·00011	−·00043	+·00021	+·00030	−·00002
9 17 ...	−·00029	−·00043	−·00069	−·00125	−·00104	−·00075	−·00066	−·00112	−·00123	−·00108	−·00005	−·00020	−·00073
Average progressive increase *per* day ...	+·00011	−·00002	−·00014	−·00014	−·00011	+·00001	+·00015	−·00002	+·00003	·00000	+·00007	+·00016	+·00001

Table 153.—Vertical Force Magnetograph.

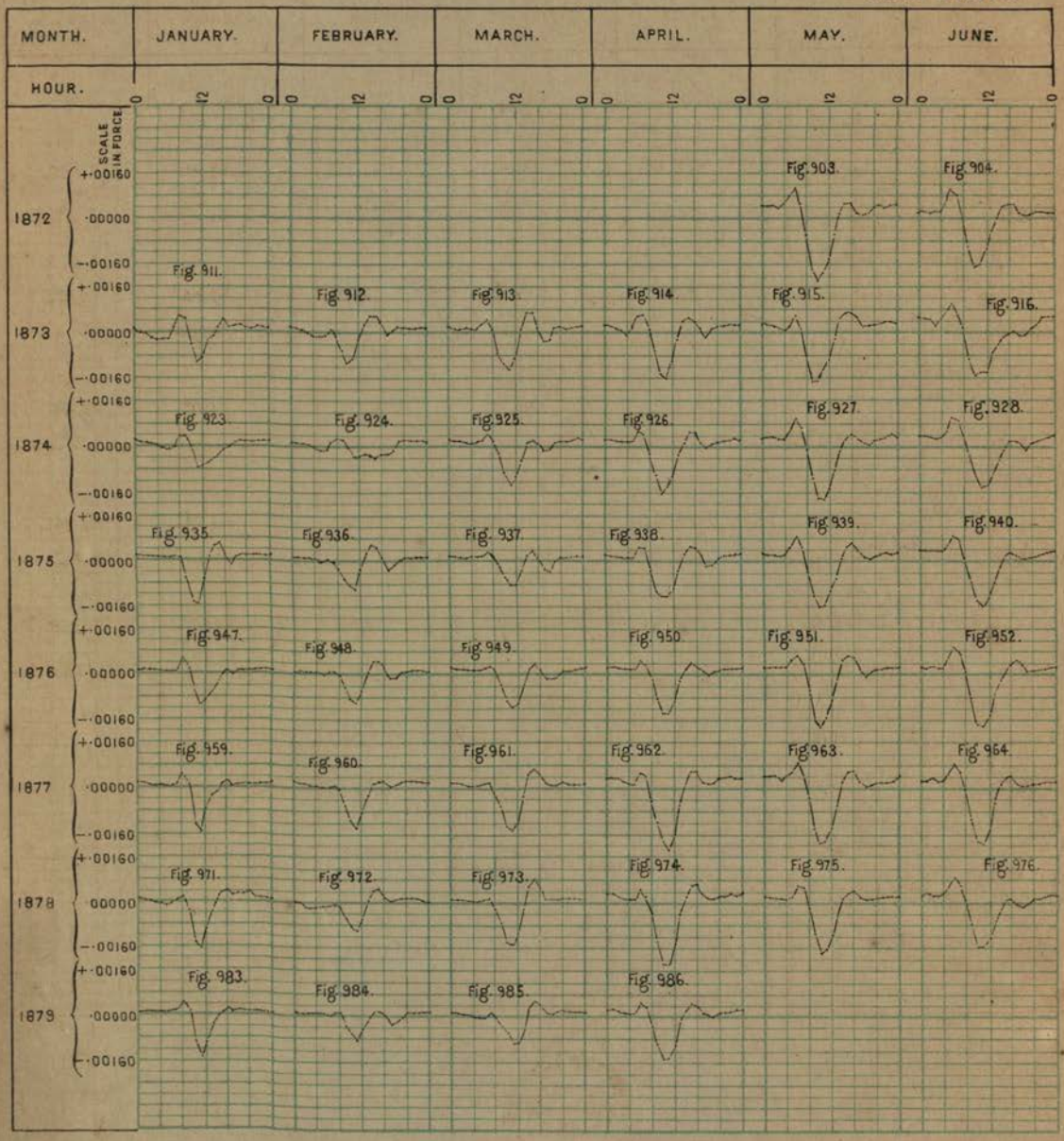
Showing the mean diurnal variation of Vertical Force for the months January to April of the year 1879.

1879. Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
h. m.													
10 17 ...	−·00086	−·00057	−·00055	−·00141									
11 17 ...	−·00139	−·00080	−·00089	−·00136									
12 17 ...	−·00086	−·00041	−·00084	−·00094									
13 17 ...	−·00029	+·00001	−·00040	−·00016									
14 17 ...	·00000	+·00024	+·00040	+·00031									
15 17 ...	+·00019	+·00024	+·00060	+·00047									
16 17 ...	+·00034	+·00005	+·00045	+·00042									
17 17 ...	+·00014	−·00020	+·00015	+·00016									
18 17 ...	+·00024	−·00012	+·00010	+·00005									
19 17 ...	+·00024	−·00001	+·00020	·00000									
20 17 ...	+·00024	+·00010	+·00030	+·00016									
21 17 ...	+·00019	+·00013	+·00025	+·00021									
22 17 ...	+·00014	+·00013	+·00020	+·00026									
23 17 ...	+·00014	+·00016	+·00020	+·00037									
0 17 ...	+·00014	+·00019	+·00020	+·00037									
1 17 ...	+·00010	+·00015	+·00020	+·00037									
2 17 ...	+·00014	+·00017	+·00010	+·00026									
3 17 ...	+·00014	+·00016	+·00005	+·00021									
4 17 ...	+·00014	+·00017	·00000	+·00016									
5 17 ...	+·00014	+·00012	·00000	+·00026									
6 17 ...	+·00019	+·00003	·00000	+·00058									
7 17 ...	+·00029	+·00018	+·00020	+·00037									
8 17 ...	+·00048	+·00019	·00000	−·00031									
9 17 ...	+·00019	−·00031	−·00030	−·00094									
Average progressive increase *per* day ...	+·00002	+·00004	−·00014	−·00012									

COLABA OBSERVATORY.

VERTICAL FORCE MAGNETOGRAPH. DIURNAL VARIATION.

Plate XXXIV.



COLABA OBSERVATORY.

VERTICAL FORCE MAGNETOGRAPH. DIURNAL VARIATION.

Plate XXXIV. *Continued.*

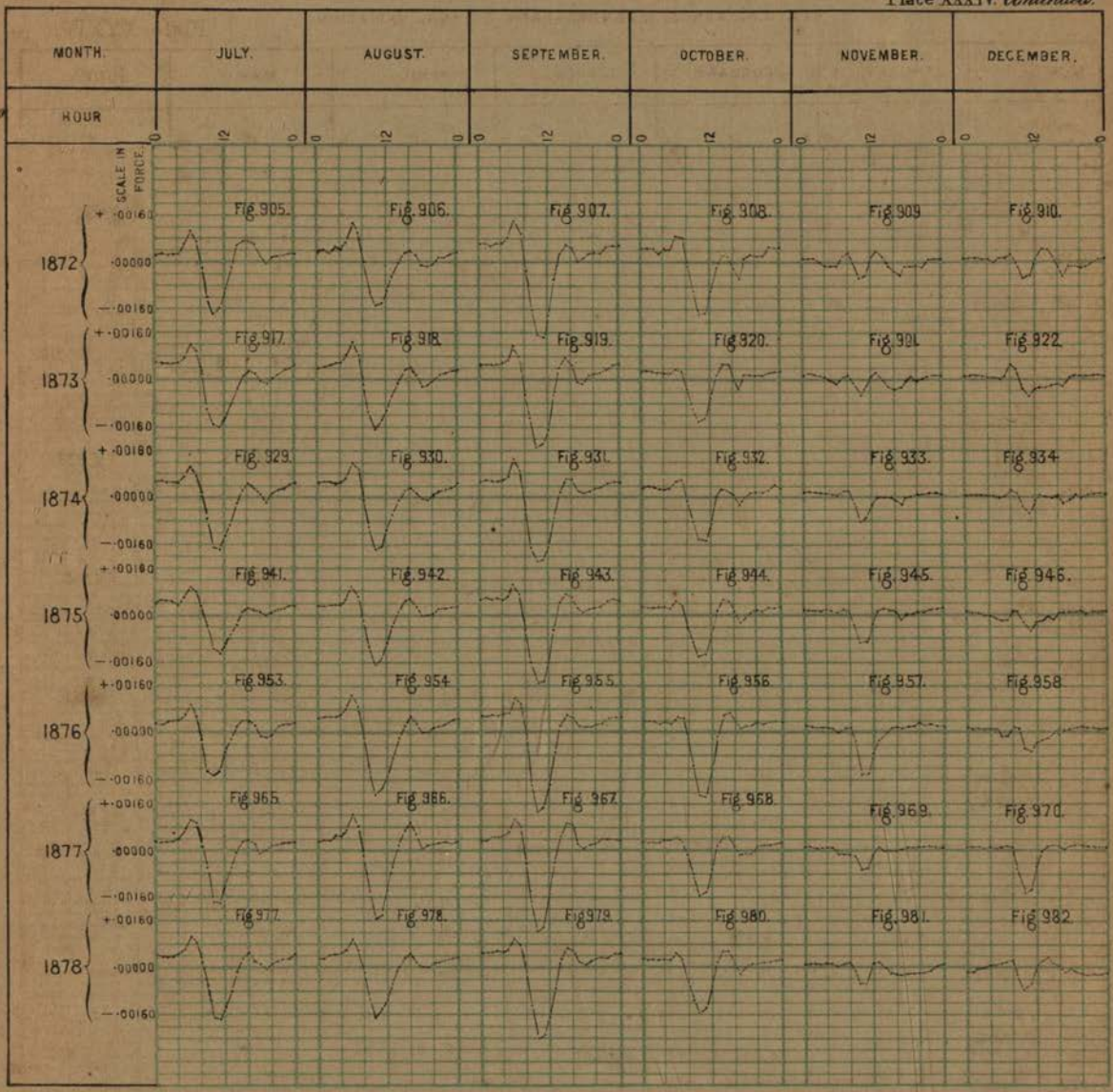


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Table 154.—Declination Magnetograph.

Showing, for the period 1871 *to* 1881, *the mean diurnal variation of Declination for each month of the year and for the whole year.*

Bombay Civil Time.	MONTH.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 18 ...	+ ·00066	+ ·00030	+ ·00072	+ ·00019	− ·00075	− ·00022	− ·00037	− ·00079	− ·00067	− ·00040	− ·00017	− ·00010	− ·00013
11 18 ...	− ·00017	− ·00007	− ·00028	− ·00119	− ·00188	− ·00152	− ·00151	− ·00197	− ·00216	− ·00130	− ·00064	− ·00040	− ·00109
12 18 ..	− ·00045	− ·00036	− ·00116	− ·00198	− ·00246	− ·00228	− ·00210	− ·00259	− ·00287	− ·00150	− ·00039	− ·00020	− ·00153
13 18 ...	− ·00017	− ·00015	− ·00123	− ·00191	− ·00211	− ·00223	− ·00213	− ·00247	− ·00249	− ·00091	+ ·00016	+ ·00025	− ·00128
14 18 ...	− ·00007	+ ·00006	− ·00060	− ·00131	− ·00132	− ·00169	− ·00164	− ·00176	− ·00135	− ·00017	+ ·00034	+ ·00047	− ·00075
15 18 ...	+ ·00016	+ ·00021	+ ·00011	− ·00053	− ·00047	− ·00099	− ·00088	− ·00073	− ·00020	+ ·00043	+ ·00039	+ ·00048	− ·00017
16 18 ...	+ ·00033	+ ·00022	+ ·00025	+ ·00001	+ ·00015	− ·00038	− ·00026	+ ·00008	+ ·00042	+ ·00044	+ ·00028	+ ·00044	+ ·00016
17 18 ...	+ ·00012	− ·00011	− ·00009	+ ·00005	+ ·00025	− ·00005	+ ·00001	+ ·00033	+ ·00026	− ·00012	+ ·00001	+ ·00021	+ ·00007
18 18 ...	+ ·00005	− ·00027	− ·00041	− ·00025	− ·00009	− ·00010	− ·00007	+ ·00002	− ·00012	− ·00020	+ ·00010	+ ·00022	− ·00009
19 18 ...	+ ·00021	− ·00004	− ·00032	− ·00038	− ·00042	− ·00046	− ·00051	− ·00031	− ·00017	− ·00009	+ ·00016	+ ·00025	− ·00017
20 18 ...	+ ·00018	− ·00001	− ·00020	− ·00032	− ·00037	− ·00045	− ·00054	− ·00037	− ·00012	− ·00003	+ ·00014	+ ·00021	− ·00016
21 18 ...	+ ·00016	− ·00002	− ·00013	− ·00016	− ·00020	− ·00031	− ·00041	− ·00027	− ·00006	− ·00002	+ ·00015	+ ·00018	− ·00009
22 18 ...	+ ·00018	+ ·00012	− ·00005	+ ·00002	− ·00001	− ·00011	− ·00023	− ·00013	+ ·00003	+ ·00010	+ ·00023	+ ·00018	+ ·00003
23 18 ...	+ ·00020	+ ·00017	+ ·00007	+ ·00016	+ ·00015	+ ·00010	− ·00004	·00000	+ ·00018	+ ·00023	+ ·00031	+ ·00023	+ ·00015
0 18 ...	+ ·00022	+ ·00025	+ ·00013	+ ·00029	+ ·00029	+ ·00027	+ ·00018	+ ·00016	+ ·00028	+ ·00026	+ ·00032	+ ·00022	+ ·00024
1 18 ...	+ ·00017	+ ·00020	+ ·00009	+ ·00037	+ ·00037	+ ·00039	+ ·00032	+ ·00027	+ ·00033	+ ·00026	+ ·00025	+ ·00016	+ ·00026
2 18 ...	+ ·00003	+ ·00013	+ ·00003	+ ·00033	+ ·00040	+ ·00046	+ ·00040	+ ·00034	+ ·00036	+ ·00022	+ ·00015	+ ·00004	+ ·00024
3 18 ...	− ·00018	− ·00005	− ·00008	+ ·00025	+ ·00038	+ ·00045	+ ·00046	+ ·00041	+ ·00034	+ ·00009	− ·00005	− ·00014	+ ·00016
4 18 ...	− ·00040	− ·00024	− ·00018	+ ·00014	+ ·00040	+ ·00046	+ ·00052	+ ·00048	+ ·00032	− ·00004	− ·00025	− ·00033	+ ·00007
5 18 ...	− ·00060	− ·00045	− ·00023	+ ·00018	+ ·00069	+ ·00081	+ ·00089	+ ·00082	+ ·00047	− ·00007	− ·00044	− ·00053	+ ·00013
6 18 ...	− ·00075	− ·00055	− ·00006	+ ·00092	+ ·00181	+ ·00194	+ ·00203	+ ·00210	+ ·00149	+ ·00023	− ·00064	− ·00065	+ ·00066
7 18 ...	− ·00077	− ·00039	+ ·00074	+ ·00184	+ ·00240	+ ·00252	+ ·00255	+ ·00286	+ ·00263	+ ·00095	− ·00049	− ·00088	+ ·00116
8 18 ...	+ ·00004	+ ·00022	+ ·00134	+ ·00194	+ ·00208	+ ·00227	+ ·00222	+ ·00242	+ ·00224	+ ·00108	·00000	− ·00043	+ ·00128
9 18 ...	+ ·00085	+ ·00062	+ ·00140	+ ·00128	+ ·00075	+ ·00111	+ ·00107	+ ·00091	+ ·00088	+ ·00049	+ ·00017	+ ·00008	+ ·00080

Table 155.—Horizontal Force Magnetograph.

Showing, for the period 1872 *to* 1879, *the mean diurnal variation of Horizontal Force for each month of the year and for the whole year.*

Bombay Civil Time.	MONTH.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 19 ...	+ ·00225	+ ·00295	+ ·00365	+ ·00393	+ ·00317	+ ·00287	+ ·00279	+ ·00260	+ ·00246	+ ·00270	+ ·00283	+ ·00232	+ ·00288
11 19 ...	+ ·00265	+ ·00335	+ ·00408	+ ·00411	+ ·00338	+ ·00302	+ ·00311	+ ·00297	+ ·00285	+ ·00307	+ ·00286	+ ·00242	+ ·00316
12 19 ...	+ ·00231	+ ·00303	+ ·00350	+ ·00343	+ ·00285	+ ·00278	+ ·00296	+ ·00287	+ ·00268	+ ·00254	+ ·00223	+ ·00204	+ ·00277
13 19 ...	+ ·00153	+ ·00213	+ ·00236	+ ·00241	+ ·00210	+ ·00214	+ ·00234	+ ·00230	+ ·00204	+ ·00145	+ ·00125	+ ·00134	+ ·00195
14 19 ...	+ ·00081	+ ·00112	+ ·00114	+ ·00127	+ ·00113	+ ·00120	+ ·00142	+ ·00140	+ ·00114	+ ·00045	+ ·00048	+ ·00066	+ ·00102
15 19 ...	+ ·00024	+ ·00031	+ ·00012	+ ·00040	+ ·00024	+ ·00021	+ ·00035	+ ·00042	+ ·00031	− ·00025	− ·00015	+ ·00017	+ ·00020
16 19 ...	− ·00021	− ·00033	− ·00048	− ·00027	− ·00046	− ·00056	− ·00044	− ·00035	− ·00025	− ·00059	− ·00062	− ·00027	− ·00040
17 19 ...	− ·00057	− ·00062	− ·00081	− ·00075	− ·00087	− ·00105	− ·00098	− ·00076	− ·00059	− ·00084	− ·00093	− ·00065	− ·00078
18 19 ...	− ·00069	− ·00083	− ·00106	− ·00111	− ·00117	− ·00132	− ·00121	− ·00097	− ·00081	− ·00099	− ·00098	− ·00072	− ·00099
19 19 ...	− ·00085	− ·00093	− ·00129	− ·00140	− ·00123	− ·00124	− ·00126	− ·00112	− ·00098	− ·00111	− ·00121	− ·00086	− ·00112
20 19 ...	− ·00107	− ·00115	− ·00148	− ·00153	− ·00131	− ·00124	− ·00128	− ·00121	− ·00111	− ·00122	− ·00125	− ·00105	− ·00124
21 19 ...	− ·00124	− ·00146	− ·00163	− ·00159	− ·00135	− ·00121	− ·00123	− ·00126	− ·00122	− ·00130	− ·00128	− ·00114	− ·00133
22 19 ...	− ·00124	− ·00172	− ·00160	− ·00165	− ·00134	− ·00119	− ·00112	− ·00117	− ·00118	− ·00117	− ·00121	− ·00111	− ·00131
23 19 ...	− ·00112	− ·00168	− ·00158	− ·00151	− ·00129	− ·00111	− ·00108	− ·00108	− ·00105	− ·00095	− ·00108	− ·00109	− ·00122
0 19 ...	− ·00106	− ·00147	− ·00144	− ·00148	− ·00125	− ·00105	− ·00108	− ·00101	− ·00097	− ·00078	− ·00098	− ·00098	− ·00113
1 19 ...	− ·00088	− ·00134	− ·00132	− ·00144	− ·00116	− ·00096	− ·00110	− ·00101	− ·00085	− ·00073	− ·00082	− ·00088	− ·00104
2 19 ...	− ·00091	− ·00123	− ·00124	− ·00131	− ·00116	− ·00097	− ·00108	− ·00097	− ·00071	− ·00069	− ·00081	− ·00084	− ·00099
3 19 ...	− ·00077	− ·00097	− ·00113	− ·00120	− ·00104	− ·00094	− ·00106	− ·00095	− ·00060	− ·00058	− ·00074	− ·00077	− ·00090
4 19 ...	− ·00064	− ·00088	− ·00097	− ·00115	− ·00099	− ·00092	− ·00101	− ·00090	− ·00057	− ·00051	− ·00065	− ·00064	− ·00082
5 19 ...	− ·00051	− ·00073	− ·00090	− ·00113	− ·00093	− ·00090	− ·00094	− ·00085	− ·00051	− ·00056	− ·00050	− ·00050	− ·00075
6 19 ...	− ·00025	− ·00054	− ·00082	− ·00101	− ·00067	− ·00047	− ·00060	− ·00071	− ·00064	− ·00052	− ·00022	− ·00025	− ·00056
7 19 ...	+ ·00012	− ·00006	− ·00029	− ·00043	− ·00001	+ ·00021	+ ·00003	− ·00037	− ·00071	− ·00014	+ ·00045	+ ·00028	− ·00008
8 19 ...	+ ·00072	+ ·00092	+ ·00093	+ ·00082	+ ·00105	+ ·00101	+ ·00082	+ ·00048	− ·00003	+ ·00080	+ ·00130	+ ·00093	+ ·00081
9 19 ...	+ ·00142	+ ·00201	+ ·00237	+ ·00251	+ ·00217	+ ·00189	+ ·00183	+ ·00160	+ ·00132	+ ·00182	+ ·00208	+ ·00161	+ ·00189
Average progressive increase *per* day... ...	− ·00017	− ·00010	− ·00012	− ·00020	− ·00022	− ·00023	− ·00021	− ·00017	− ·00019	− ·00013	− ·00015	− ·00011	− ·00017

COLABA OBSERVATORY. DIURNAL VARIATIONS.

Plate XXXV.

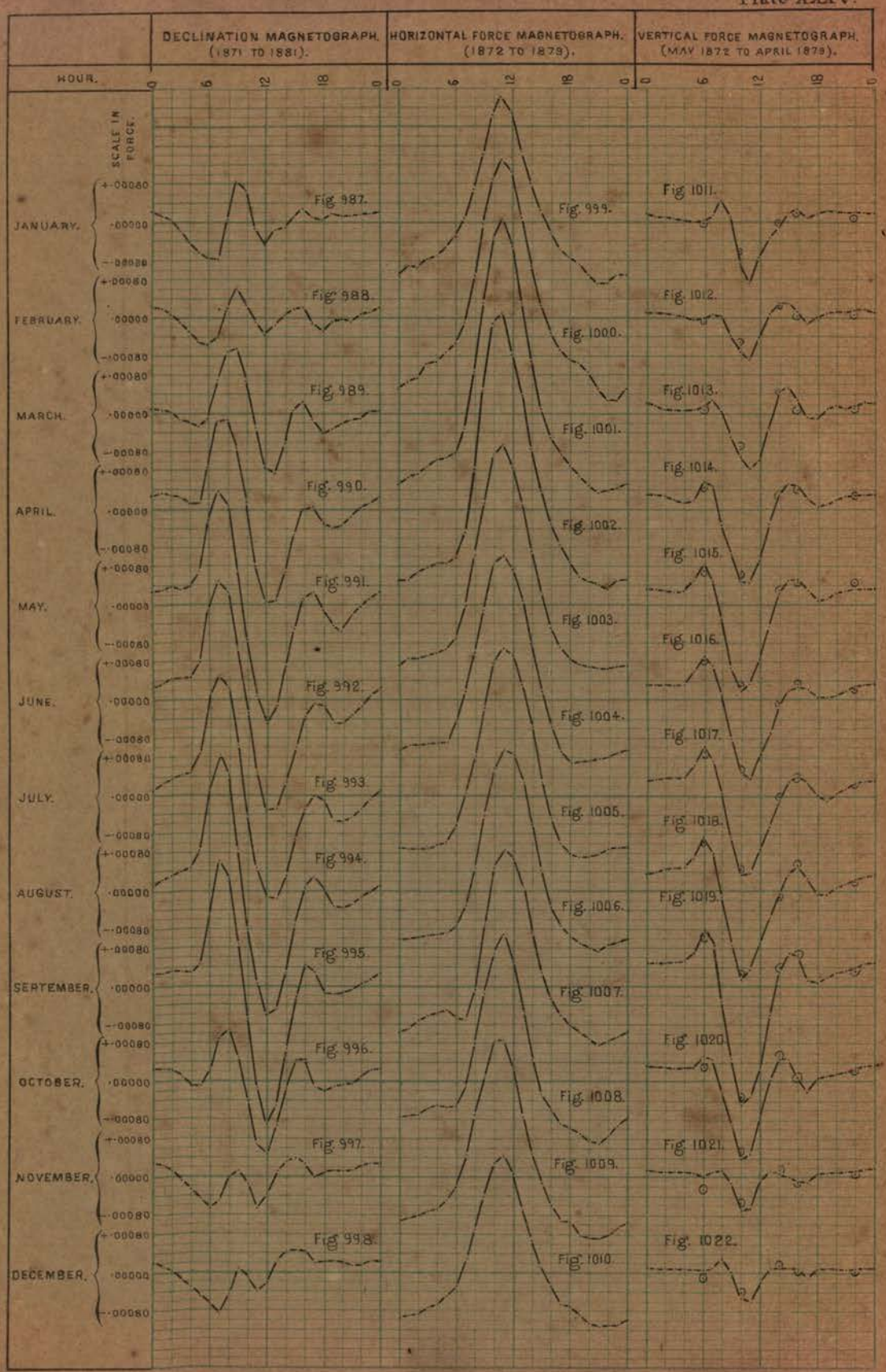

TABLE 156.—VERTICAL FORCE MAGNETOGRAPH.

Showing, for the period May 1872 to April 1879, the mean diurnal variation of Vertical Force for each month of the year and for the whole year.

Bombay Civil Time.	MONTH.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 17 ...	−·00084	−·00074	−·00093	−·00155	−·00180	−·00153	−·00162	−·00184	−·00245	−·00159	−·00073	−·00057	−·00135
11 17 ...	−·00124	−·00086	−·00118	−·00157	−·00163	−·00162	−·00161	−·00165	−·00237	−·00152	−·00067	−·00061	−·00138
12 17 ...	−·00077	−·00044	−·00096	−·00107	−·00117	−·00116	−·00113	−·00116	−·00167	−·00077	−·00013	−·00019	−·00088
13 17 ...	−·00031	+·00006	−·00029	−·00030	−·00044	−·00065	−·00064	−·00058	−·00061	+·00004	+·00013	+·00006	−·00029
14 17 ...	−·00004	+·00034	+·00042	+·00029	+·00022	−·00017	−·00008	−·00004	+·00032	+·00048	+·00007	+·00009	+·00016
15 17 ...	+·00020	+·00033	+·00057	+·00056	+·00053	+·00019	+·00030	+·00037	+·00071	+·00047	·00000	+·00008	+·00036
16 17 ...	+·00029	+·00018	+·00031	+·00051	+·00057	+·00031	+·00041	+·00053	+·00061	+·00009	−·00007	+·00007	+·00032
17 17 ...	+·00009	−·00011	−·00002	+·00021	+·00032	+·00022	+·00025	+·00027	+·00014	−·00022	−·00013	−·00008	+·00008
18 17 ...	+·00019	+·00001	−·00004	+·00005	+·00009	+·00004	+·00001	−·00006	+·00006	+·00005	+·00004	+·00006	+·00004
19 17 ...	+·00025	+·00014	+·00013	+·00010	+·00014	+·00003	−·00009	−·00005	+·00020	+·00012	+·00005	+·00008	+·00009
20 17 ...	+·00024	+·00018	+·00020	+·00021	+·00024	+·00012	+·00005	+·00007	+·00028	+·00018	+·00008	+·00006	+·00016
21 17 ...	+·00022	+·00018	+·00017	+·00026	+·00030	+·00021	+·00016	+·00016	+·00034	+·00019	+·00009	+·00004	+·00019
22 17 ...	+·00022	+·00020	+·00019	+·00032	+·00035	+·00031	+·00028	+·00023	+·00041	+·00031	+·00015	+·00009	+·00025
23 17 ...	+·00021	+·00019	+·00025	+·00034	+·00036	+·00034	+·00032	+·00031	+·00048	+·00034	+·00018	+·00010	+·00028
0 17 ...	+·00021	+·00017	+·00025	+·00034	+·00037	+·00036	+·00037	+·00038	+·00051	+·00036	+·00018	+·00011	+·00030
1 17 ...	+·00013	+·00014	+·00020	+·00034	+·00036	+·00037	+·00038	+·00041	+·00053	+·00035	+·00017	+·00009	+·00029
2 17 ...	+·00011	+·00011	+·00017	+·00028	+·00033	+·00036	+·00039	+·00043	+·00052	+·00034	+·00015	+·00009	+·00027
3 17 ...	+·00007	+·00007	+·00013	+·00021	+·00028	+·00030	+·00039	+·00046	+·00054	+·00030	+·00010	+·00005	+·00024
4 17 ...	+·00004	+·00003	+·00009	+·00017	+·00029	+·00036	+·00041	+·00048	+·00057	+·00032	+·00010	+·00007	+·00024
5 17 ...	+·00001	−·00001	+·00011	+·00021	+·00052	+·00059	+·00064	+·00069	+·00069	+·00033	+·00007	+·00005	+·00032
6 17 ...	+·00002	·00000	+·00021	+·00059	+·00085	+·00095	+·00101	+·00117	+·00120	+·00054	·00000	+·00003	+·00055
7 17 ...	+·00016	+·00007	+·00033	+·00045	+·00049	+·00074	+·00076	+·00081	+·00085	+·00045	+·00015	+·00008	+·00044
8 17 ...	+·00043	+·00002	+·00003	−·00025	−·00035	+·00010	+·00004	−·00015	−·00037	−·00024	+·00017	+·00028	−·00002
9 17 ...	+·00011	−·00037	−·00046	−·00097	−·00136	−·00080	−·00086	−·00118	−·00155	−·00095	−·00015	+·00001	−·00071
Average progressive increase per day... ...	+·00006	−·00002	−·00011	−·00015	−·00018	−·00003	+·00001	−·00002	−·00003	+·00001	+·00002	+·00004	−·00003

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252. The variations being, however, slightly affected by the progressive change in the values of the ordinates from the beginning to the end of the month or by the average of such changes for groups of months, the amounts of these changes *per* day are, after conversion into force, stated at the feet of the several columns of tables 137 to 153, 155 and 156, so that allowance can, if desired, be made for them by the reader. In the case of the declination they are, however, quite insignificant in amount and are therefore not entered.

253. The general character of the diurnal variations of declination, horizontal force, and vertical force is best exhibited by Figs. 1048 to 1050 of Plate XXXVI.

254. *Change from month to month in the range of mean diurnal variations.*

TABLE 157.

Ranges expressed in force.

Month.	Declination Magnetograph.	Horizontal Force Magnetograph.	Vertical Force Magnetograph.
January	·00162	·00389	·00167
February	·00117	·00507	·00120
March	·00263	·00571	·00175
April	·00392	·00576	·00216
May	·00486	·00473	·00265
June	·00480	·00434	·00257
July	·00468	·00439	·00263
August	·00545	·00423	·00301
September	·00550	·00407	·00365
October	·00258	·00437	·00213
November	·00103	·00414	·00091
December	·00136	·00356	·00089

On these numbers, and on the corresponding curves of Plate XXXV, we remark that the declination and vertical force ranges move generally together; they both have maximum values about the autumnal equinox and very low values from November to February, and the intermediate progressions are similar in character. On the other hand the maximum of the horizontal force range occurs about the vernal equinox, whilst minimum occurs about the winter solstice, and from June to November it has a comparatively steady intermediate value.

255. *Change from year to year in the range of mean diurnal variations.*

TABLE 158.

Ranges expressed in force.

Year.	Declination Magnetograph.	Horizontal Force Magnetograph.	Vertical Force Magnetograph.
1871	·00360		
1872	·00344	·00675	
1873	·00317	·00542	·00177
1874	·00248	·00481	·00184
1875	·00250	·00407	·00178
1876	·00242	·00392	·00201
1877	·00275	·00366	·00221
1878	·00243	·00357	·00196
1879	·00249	·00377	
1880	·00248		
1881	·00316		

We know (see paragraph 150) that the declination range was at a maximum about the year 1870, and we see from column 2 of this table that it gradually decreased till 1874, remained at very low value till 1880, and then began to rise again towards another maximum, all in general accordance with the sun-spot period. The horizontal force ranges show a similar progression as far as they go; but those of vertical force are on the average of the first three years of the table somewhat smaller than on the average of the last three years, and they show as yet no relation to the sun-spot period.

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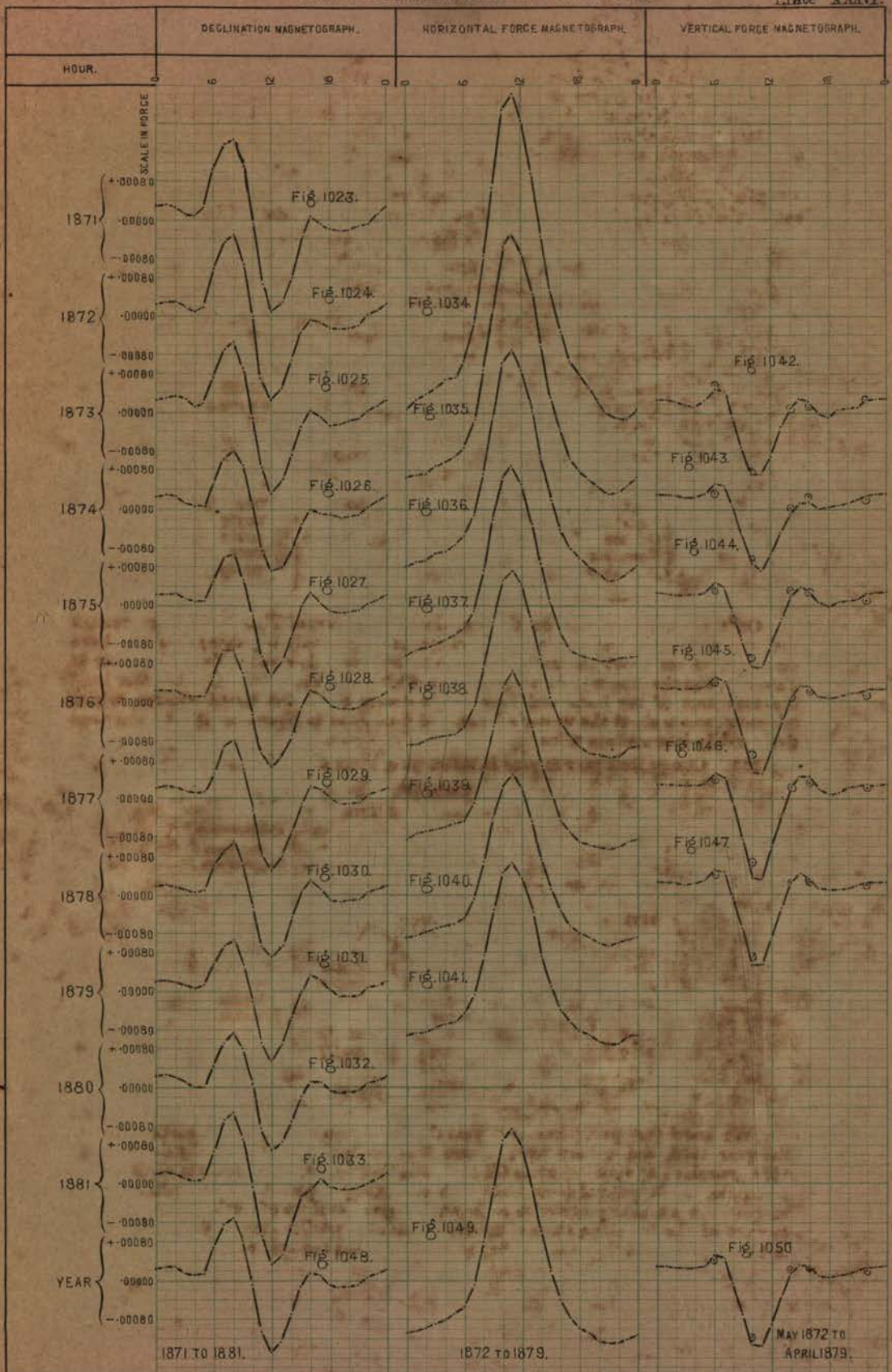
Plate XXXVI.



256. *Mean readings of the thermometers enclosed with the horizontal force and vertical force magnetographs.*—These means, for each month of the year, are derived in the case of the horizontal force thermometer from observations taken between January 1873 and February 1875* and between March 1877 and December 1882, and in the case of the vertical force thermometer from observations taken between May 1872 and April 1879, the observations being taken, in both cases, at the hours 6, 10, 14, 16 and 22 : and they are accompanied, in the following table, by the inequalities at each of the five hours as compared with the mean of all.

TABLE 159.

Month.	Thermometer of Horizontal Force Magnetograph.							Thermometer of Vertical Force Magnetograph.						
	Inequalities.							Inequalities.						
	Hour.					Range.	Mean of five hours.	Hour.					Range.	Mean of five hours.
	6	10	14	16	22			6	10	14	16	22		
January ...	+·03	+·06	·00	−·04	−·06	0·12	86·43	−·01	+·10	+·01	−·03	−·05	0·15	86·33
February ...	+·03	+·07	−·03	−·07	−·02	·14	85·97	−·02	+·10	−·01	−·06	−·03	·16	85·83
March ...	+·02	+·10	−·03	−·08	−·01	·18	87·52	−·03	+·12	·00	−·07	−·01	·19	86·89
April ...	+·01	+·09	−·03	−·06	−·02	·15	89·52	−·06	+·07	·00	−·03	·00	·13	89·00
May ...	+·01	+·03	−·02	−·04	+·01	·07	91·68	−·05	+·03	+·02	−·02	+·03	·08	91·50
June ...	·00	+·02	+·01	+·01	−·03	·05	92·88	−·04	+·03	+·03	+·02	−·02	·07	93·04
July ...	−·03	−·01	+·01	+·02	+·01	·05	91·46	−·02	+·03	+·02	·00	−·02	·05	91·16
August ...	−·03	+·01	+·01	+·01	·00	·04	90·63	−·06	+·04	+·03	+·02	−·01	·10	89·97
September .	−·02	+·04	·00	−·01	−·02	·06	90·36	−·07	+·05	+·04	+·01	−·03	·12	89·45
October ...	+·01	+·05	·00	−·03	−·03	·08	90·15	−·07	+·07	+·04	·00	−·02	·14	89·39
November .	+·02	+·05	+·01	−·02	−·05	·10	89·41	−·09	+·08	+·03	−·01	−·03	·17	88·99
December...	+·03	+·05	·00	−·04	−·04	·09	88·02	−·06	+·07	+·03	−·01	−·03	·13	88·11
Year ...	+·01	+·05	−·01	−·03	−·02			−·05	+·07	+·02	−·01	−·02		

257. In no month is the daily range, between any of the five hours, greater than 0°·18 for the horizontal force thermometer or 0°·19 for the vertical force thermometer, or than ·00006 or ·00046 expressed in force ; and during the monsoon months the respective average ranges are only 0°·05 and 0°·08. The effect of ignoring these small quantities, as affecting the deduced diurnal variations of horizontal force, is quite insignificant. It is small too as affecting the diurnal variations of vertical force, but not insignificant. On the general curve of diurnal variation of vertical force (Fig. 1050) and on the monthly curves (Figs. 1011 to 1022) points are marked, enclosed by small circles, showing the extent to which the curves would be modified if allowance were made for the small temperature variations that we have just found : the rate at which an increase of one degree of temperature was taken as affecting the force indicated by the scale readings was —·00240. (*See* Table 24, First set of experiments on page [57]).

Similar points are marked also on Figs. 1042 to 1047 and the corresponding temperature inequalities for the several years appear in Table 160.

TABLE 160.

Year.	Thermometer of Vertical Force Magnetograph.						
	Inequalities.						
	Hour.					Range.	Mean of five hours.
	6	10	14	16	22		
1873 ...	+·03	+·01	·00	−·04	+·01	·07	88·64
1874 ...	−·09	+·02	+·05	+·04	−·02	·14	86·68
1875 ...	−·07	+·07	+·05	·00	−·03	·14	88·79
1876 ...	−·06	+·14	−·01	−·06	−·04	·20	89·41
1877 ...	−·06	+·11	·00	−·04	−·03	·17	90·86
1878 ...	−·04	+·06	+·01	−·02	−·01	·10	90·28

* On the 9th March 1875 the ivory scale of the horizontal force thermometer cracked by reason of long exposure to the attenuated dry air of the enclosure, and the thermometer, falling down, was no more read till the enclosure was next opened in February 1877.

258. *Rules observed in the treatment of imperfect magnetograms.*—When for any reason the photographic traces furnished by the magnetographs are interrupted, and the interruption includes the moments when one or more hourly tabulations should be made, these last are either substituted by the corresponding eye-observations, if the hours should happen to be any of the five regular observation hours, or if special eye-observations were taken for the purpose, or else, if no eye-observations are available, they are interpolated. In the last case, if the interruption lasts for less time than one hour, the interpolation is made on the assumption that the rate of change of the phenomenon from its value at the beginning to its value at the end of the interruption was uniform, providing that the parts of the curve immediately preceding and immediately following the gap were, in appearance, continuations of the straight line connecting the extremities of the gap. If the last condition is not satisfied, or if the gap, taking account of points inserted by means of eye-observations, is of greater length than one hour, the interpolation is made between the next preceding and the next following hourly entries, first, by allowing for the known *normal* rate of change of the phenomenon between those hours in the same month, and then by assuming that any additional change, shown by the difference between the values of the phenomenon at the two extreme hours, has grown at a uniform rate. Interpolated values are entered in the abstract sheets with enclosing square brackets—inserted eye-observations between parenthesis. In statements that follow each case of interruption is marked by a number signifying that the interpolation or substitution has been made by one of four rules, *viz.*: [1] by interpolation as first described above, [2] by interpolation as last described above when no modified eye-observations are inserted, [3] the same when one or more modified eye-observations are inserted, and [4] by the insertion of equivalents of the readings of the old magnetometers after reduction of these to the proper minute of the missing tabulations. Hours for which eye-observations of the identical instrument were available are marked within parenthesis.

In tabulating the magnetograms no regard is paid to events that have been noted as possible disturbances of the record—such as the occasional use of tools in the magnetograph room, bringing near of a small magnet in the course of deflection experiments made upon either of the two other instruments, or the approach of vehicles or other large bodies containing iron in their structure, unless they cause evident and irregular (and therefore ineradicable) disruptions of the curve, and in this case the disturbed part of the curve is rejected and treated as an interruption. Also in tabulating curves that exhibit experimental deflections made upon the instrument itself, the deflections are treated as interruptions. In the declination and horizontal force magnetograms, and sometimes in those of the vertical force, dislocations generally come in pairs, of equal and opposite amount, the one on the introduction and the other on the reversal of a cause of disturbance, and in these cases the disturbance is measured and eliminated during the interval of its action; but accidental disturbances occur in the vertical force magnetograms that are not afterwards reversed, and for these the lesser portion of the day's curve is corrected so as to make the whole day comparable, but no attempt is made to restore the comparability from day to day that may be supposed to have existed before the disturbance occurred. If the curve is lost for the proper moment of tabulation but is available for a minute before or a minute after, the tabulation is made for the adjacent minute and is adopted as that of the proper moment. It should have been mentioned before that the magnetographs, like the Colába barograph and thermograph (*see* Magnetical and Meteorological Observations 1871 to 1878, Introduction page xx), are provided with automatic shutters which close at two minutes before and open two minutes after each even hour, thus cutting off the light for four minutes and dividing the magnetic curves and their datum lines into two-hour sections; the clockwork is well made, so that the occurrence of the interruptions is never more than a minute in error; and care is taken to keep the rate of the clock small, and to set the clock accurately every day, and with these precautions it is considered allowable to regard the two-hour breaks in the curves as marking accurately the even hours of the day, though they are always tested, by seeing that the first and last breaks agree with the times of starting and stopping the clock, before the commencement of a day's tabulations. The time-lines on the index glasses of the tabulator are at 0^m, 17^m and 19^m, the first of which is set on the two-hourly break, whilst the others and the space midway between them mark the minutes 17, 18 and 19 for which tabulations of the several curves have to be made; the tabulations for the odd hours are obtained by moving forward the T frame by the space of one hour upon its accurately divided time-scale,—a movement that is effected with great facility by means of hourly notches cut on the edge of the scale. Examples of magnetograms, showing the two-hourly breaks appear on Plate IV.

When portions of a day's datum line aggregating less than twelve hours have been lost or been too faint for tabulation, they have been substituted by imaginary straight lines connecting or continuing the portions of the remaining twelve or more hours of the datum. If one of the two datum lines on a curve sheet be complete or be completed as first described, and the other is missing through a greater aggregate than twelve hours, the relation between the two is obtained by measurement at a number of corresponding points, and the mean difference between them is applied as a correction to tabulations made from the complete datum line of the other day's curve. In one instance (out of four) in which both days' datum lines are lost or incomplete, the tabulations of both days were made from a straight datum line drawn upon the paper, and corrections both for the error of position and error of inclination of this line were deduced from the corresponding eye-observations and tabulations of each day.

Until May 1872 care was taken by the photographer to commence the daily alterations—changing of therecording papers or moving onward of the cylinders—a littleafter the times (17^m to 19^m after the hour) at which tabulations are made, but, by some misapprehension, he then began to encroach on or keep clear of these times indifferently, and his change of habit was not discovered till July 1873. During the interval there were consequently many cases in which the curves were lost for the hour 9; and for each of these cases ordinates were interpolated (by rule 1) from tabulations at the final point of the preceding curve and at the initial point of the following curve.

Such cases are—

(*a*). Affecting the set of three magnetograms—1872, May 10^d and 29^d; June 9^d, 17^d and 19^d; and 1873, July 7^d.

(*b*). Affecting the declination magnetograms alone—1872, May 17^d, 19^d and 23^d; June 4^d, 7^d, 25^d and 29^d; July 9^d, and August 11^d; and 1873, January 4^d, April 22^d, May 12^d and July 11^d.

(*c*). Affecting the horizontal force magnetograms alone—1872, May 14^d, 17^d and 24^d; June 4^d, 7^d, 11^d, 13^d, 15^d, 25^d and 29^d; July 9^d and 29^d; August 21^d and 22^d; September 8^d, 12^d, 18^d and 22^d; and October 10^d; and 1873, January 4^d, May 12^d, and July 11^d.

(*d*). Affecting the vertical force magnetograms alone—1872, May 9^d, 11^d and 23^d; June 8^d, 10^d and 18^d; August 5^d and 11^d; October 2^d; and November 9^d.

259. *Statement of irregularities of procedure.*—The following statement shows all the irregularities of procedure, except those just mentioned, that have been rendered necessary by extraneous disturbing influences or by imperfections in the working or management of the instruments.

For 1872, December 13^d-10^h to 14^d-9^h and for 1873, January 5^d-10^h to 6^d-9^h apparent errors of 10 minutes in the setting of the clock dial were allowed for.

Declination Magnetograph.

260. *List of days the curves of which were rejected.*

1872, January 28.—Clock stopped (28^d 22^h 50^m to 29^d 9^h 42^m) by accidental entanglement of trial paper in wheelwork. The day being Sunday no eye-observations were available to substitute for the lost curves.

1875, September 26.—Curves lost—owing to bad quality of waxed paper or bad photography.

1878, July 5, 6 } Curves too faint for tabulation—owing to bad quality of waxed paper.

261. *Curves very faint but tabulated on the assumption that the tabulated values are preferable to interpolations.*

For 1871, January 10^d-0^h to 9^h and 10^d-15^h to 11^d-9^h; 1875, September 27^d-10^h to 28^d-9^h; and 1878, April 3^d-10^h to 5^d-9^h; July 7^d-10^h to 13^h; and October 1^d-12^h to 22^h.

262. *Curve affected and corrections applied to tabulations.*

1871, May and June.—From May 10 to June 13 workmen were at times engaged in the magnetograph room between the hours of 10 and $18\frac{1}{2}$; the occasions on which their iron tools produced sensible effects were as follows:—

10d 13h to 18h : Magnet in oscillation but curve not dislocated : tabulations made with regard to the general course of the curve.

11d 15h and 16h. Dislocation of – ·023 was allowed for.
12d 9h do. – ·050 do.
12d 11h do. – ·027 do.
12d 12h do. – ·044 do.
15d 16h do. – ·069 do.

16d 12h to 18h : Magnet in oscillation but curve not dislocated : tabulations made with regard to the general course of the curve.

1872, January 24.—Vertical force magnet taken out of room at 16h ; dislocation of – ·032 was allowed for.

1872, March 4.—Horizontal force magnet under vibration in changed position : dislocation of – ·028 allowed for at 13h and 14h.

1875, September 19d 18h to 20d 7h } Magnet in oscillation owing to gradual failure of vacuum : tabulations made with regard to the general course of the curves.
„ „ 21d 3h and 6h to 8h }

1876, July 7d 16h to 18h } Vertical force magnet taken out of room ; dislocation of
„ „ 8d 8h to 17h } – ·025 was allowed for.

1876, December 31d 10h to 14h.—Adjusted diaphragm on lens to verticality : dislocation of datum line of + ·008 was allowed for.

1880, January 14d to 20d.—Vertical force magnet taken out of room :

Dislocation of – ·022 allowed for from 14d 16h to 15d 10h.
Do. – ·027 do. at 15d 14h.
Do. – ·024 do. from 15d 15h to 18h.
Do. – ·019 do. at 16d 11h and 12h.
Do. – ·022 do. from 16d 17h to 18d 15h.
Do. – ·022 do. from 18d 18h to 19d 9h.
Do. – ·026 do. from 19d 11h to 21h.
Do. – ·020 do. at 20d 8h.
Do. – ·023 do. at 20d 12h and 13h.

263. *Entries in abstracts obtained by interpolation or by substitution of eye-observations—not by direct tabulation.*

	Rule of interpolation, &c.
(1). Owing to stoppage of the clock :	
for 1877, July 11d 18h ; and 1878, January 18d 16h and 24d 20h.	[1*]
for 1874, January 8d 2h and December 22d 13h ; 1875, January 14d 13h ; 1881, November 13d 9h ; and 1882, January 19d 8h...	[2]
for 1873, July 28d 3h to (6h) ; 1874, April 29d 5h and (6h) ; 1875, January 14d 21h, (22h) and 23h ; and 1880, March 31d 20h to (22h)	[2 and 3]
for 1879, December 18d (16h) ; and 1881, September 11d (6h) ...	[3]
(2). Clock being cleaned or taken to pieces : 1874, April 29d 8h to (10h) and 11h to 13h	[2 and 3]
(3). Derangement of clockwork being rectified : for 1877, February 27d (10h)	[3]
(4). String of driving weight deranged whilst winding the clock :	
for 1871, February 4d, 16h...	[1 and 4]
for 1874, January 9d (10h)...	[3]
(5). Owing to failure of light :	
for 1871, July 28d 15h	[1]
for 1871, January 2d 5h, and 7d 7h ; 1872, June 11d 17h ; 1876, June 16d 8h ; and 1879, August 24d 9h	[2]
for 1873, August 31d 4h to (6h)	[2 and 3]
for 1874, January 12d (16h) and 24d (16h)	[3]
(6). Owing to faulty waxed paper :	
for 1877, July 26d 8h and 9h ; 1878, October 2d 8h and 9h ; and 1881, August 23d 9h	[2]

* The numbers within square brackets indicate the rules by which the interpolations or substitutions were made.

Rules of interpolation, &c.

for 1877, July 25^d (22^h) to 26^d 3^h, and 26^d (22^h) to 27^d 1^h ... [2 and 3]
for 1872, December 2^d 10^h to 3^d 2^h; and 3^d 10^h to 4^d 1^h ... [4]

(7). Owing to bad quality of photographic materials:
for 1871, January 9^d 10^h to 23^h; 10^d 10^h to 14^h and 11^d 10^h to 16^h [4]

(8). Owing to negligent manipulations in the photographic processes:
for 1872, January 21^d 8^h ... ... [1]

(9). Owing to loss of record during time of changing paper:
for 1871, January 11^d 22^h ... ... [4]

(10). Recording cylinder was not properly set at starting and trace passed over the binding rods: for 1873, July 9^d 5^h... ... [1]

(11). Instrument being readjusted or experimented with, or parts of it being cleaned: for 1872, April 16^d 13^h to 17^d 17^h ... [4]

(12). Two bar magnets brought into the room to twist the vertical force magnet in azimuth: for 1879, February 10^d 12^h ... [1]

(13). Alteration being made to increase the play of the vertical force shutter: for 1874, May 14^d (10^h)... ... ... [3]

(14). Deflection experiments going on:
for 1878, February 6^d 15^h ... ... [1]
for 1872, February 9^d 16^h; 1873, October 4^d 11^h and 12^h; and 1876, August 10^d 15^h ... ... [2]

(15). Brass slit substituted for paper slit which had been under trial: for 1875, June 7^d 11^h ... ... [1]

(16). Deflection experiment on horizontal force magnetograph set the magnet oscillating: for 1873, September 12^d 21^h ... [1]

(17). Curve affected by leakage of air into the enclosure: for 1876, July 15^d 18^h and 19^h ... ... [2]

(18). Preparation for and attempts made to pump the air out of the enclosure of the instrument:
for 1872, April 16^d 13^h to 17^d 17^h [entered also under (11)].
for 1875, July 22^d 14^h and 23^d 11^h; and 1876, June 1^d 11^h to 18^h; 2^d 11^h to 17^h; 3^d 10^h to 17^h; 5^d 11^h to 19^h; 6^d 11^h to 19^h; 8^d 12^h and 17^h; 13^d 15^h; 19^d 11^h to 17^h and 20^d 11^h to 14^h; 16^h and 17^h; and July 17^d 11^h and 12^h ... ... [2]

Horizontal Force Magnetograph.

264. *List of days the curves of which were rejected.*

1872, January 28.—Clock stopped (28^d 22^h 50^m to 29^d 9^h 42^m) by accidental entanglement of trial paper in wheelwork. The day being Sunday no eye-observations were available to substitute for the lost curves.

1872, February 21 to 23.—Instrument was being re-adjusted.

1875, September 26.—Curves lost, owing to bad quality of waxed paper or bad photography.

1878, April 3 and 4.—Curves lost, owing to bad quality of waxed paper or bad photography.

1879, February 15.—Heating experiments going on in the magnetograph room: effect of temperature changes variable and uncertain.

1880, January 26, 27 and 30.—Heating experiments going on in the magnetograph room: effect of temperature changes variable and uncertain.

265. *Curves very faint but tabulated on the assumption that the tabulated values are preferable to interpolations.*

For 1875, September 27^d 12^h to 18^h; and 1878, April 5^d 17^h to 6^d 18^h.

266. *Curve affected and corrections applied to tabulations.*

1872, January 24.—Vertical force magnet taken out of room at 16^h; dislocation of −·014 was allowed for.

1872, February 4 to 8.—Magnetic storm carrying the curve near to the edge of the field: deflector magnet placed end-on so as to increase the ordinates by 3·334 inches, and corresponding allowance made from 4^d 23^h to 8^h 11^h, after which the magnet was removed.

1872, February 28^d 10^h to 15^h.—Set of wires accidentally disturbed: change of +·324 allowed for.

1872, March 4^d 10^h and 11^h.—Set of wires experimentally disturbed: change of −·064 allowed for.

1872, March 5^d 10^h and 11^h.—Magnet accidentally knocked: change of +·054 allowed for.

1872, March 6^d 10^h to 14^h.—Disturbed during the making of certain measurements: change of +·160 allowed for.

1872, March 13^d 10^h and 11^h.—Disturbed during the exhaustion experiments: change of +·036 allowed for.

1872, March 20^d, 10^h and 11^h.—Disturbed during the exhaustion experiments: change of −·052 allowed for.

1872, March 25^d 10^h to 27^d 9^h. Inclination of both mirrors altered exactly (by accident) to the same extent. From 16^h to 9^h the curves of the two days were inextricably confused and the two datum lines very close together; and the even-hour breaks of the first day occupied positions about 17 minutes later than those of the second day. The same tabulations, using the mean curve, the mean datum, and the mean times were entered for both days. For 26^d 9^h and 15^h, the curve being lost, equivalents of the eye-observations of the horizontal force magnetometer were substituted for the missing tabulations.

1873, October 1^d 10^h and 11^h. Alteration of distance apart of the wires at top: change of +3·409 allowed for.

1876, July 7^d 16^h to 18^h ... } Vertical force magnet taken out of room; dislocation of
„ „ 8^d 8^h to 17^h ... } −·011 was allowed for.

1877, February 6^d 10^h to 13^h. Alteration of distance apart of the wires at top: change of +4·373 allowed for.

1880, January 14 to 20. Vertical force magnet taken out of room:—

dislocation of	−·016	allowed for	from 14^d 16^h to 15^d 10^h.
Do.	−·014	do.	at 15^d 14^h.
Do.	−·014	do.	from 15^d 15^h to 18^h.
Do.	−·009	do.	at 16^d 11^h and 12^h.
Do.	−·012	do.	from 16^d 17^h to 18^d 15^h.
Do.	−·013	do.	from 18^d 18^h to 19^d 9^h.
Do.	−·012	do.	from 19^d 19^h to 21^h.
Do.	−·013	do.	at 20^d 8^h.
Do.	−·010	do.	at 20^d 12^h and 13^h.

267. *Entries in abstracts obtained by interpolation or by substitution of eye-observations—not by direct tabulation.*

Rule of interpolation, &c.

(1.) Owing to stoppage of clock:
for 1875, January 14^d 13^h; 1877, July 11^d 18^h; and 1878, January 24^d 20^h ... ... [1]*
for 1874, January 8^d 2^h and December 22^d 13^h; and 1880, March, 31^d 20^h and 21^h ... ... [2]
for 1873, July 28^d 3^h to (6^h); 1874, April 29^d 5^h and (6^h); and 1875, January 14^d 21^h, (22^h) and 23^h ... ... [2 and 3]
for 1878, January 18^d (16^h); and 1879, December 18^d (16^h) ... [3]

(2.) Clock being cleaned or taken to pieces:
for 1874, April 29^d 8^h to (10^h) and 11^h to 13^h ... ... [2 and 3]

(3.) Derangement of clock-work being rectified; for 1877, February 27^d (10^h) [3]

(4.) String of driving weight deranged whilst winding the clock:
for 1874, January 9^d (10^h) ... ... [3]

* The numbers within square brackets indicate the rules by which the interpolations or substitutions were made.

Rule of interpolation, &c.

(5.) Owing to failure of light:
for 1875, January 15d 17h; and November 3d 17h; and 1877, January 2d 11h ... ... [1]
for 1872, April 27d 8h and 9h; 1873, April 1d 8h and 9h, and December 26d 3h and 4h; and 1874, December 27d 0h and 1h ... ... [2]
for 1875, April 5d 15h and (16h) ... ... [2 and 3]
for 1878, January 22d (16h) ... ... [3]

(6.) A white card used for examining the strength of the image having probably been left interposed: for 1880, July 11d 11h to 13h ... [2]

(7.) Owing to faulty waxed paper:
for 1878, July 7d (10h) to 13h and (14h) and 15h ... ... [2 and 3]

(8.) Curve lost or too faint to tabulate—photography at fault:
for 1877, March 16d 9h ... ... [1]
for 1877, March 17d 9h ... ... [2]
for 1872, June 23 (10h) and 15h; and 1875, September 27d (10h) and (11h) ... ... [2 and 3]
for 1872, February 29d 9h ... ... [4]

(9.) Recording cylinder was not properly set at starting and trace passed over the binding rods; for 1876, June 2d 9h and 6d 9h ... [1]

(10.) Recording cylinder taken out and replaced causing the curve to overlap:
for 1873, April 16d 17h ... ... [1]

(11.) Curves of two days inextricably confused: treated as lost:
for 1872, March 15d 10h to 14h and 16d 10h to 14h ... ... [4]

(12.) Dot of light passed out of field: for 1874, January 1d 9h ... [1]

(13.) Instrument being re-adjusted or experimented with, or parts of it being cleaned:
for 1873, October 1d 12h to 18h; and 1877, February 6d 14h ... [2]
for 1872, February 24d 10h to 17h; and March 1d 12h and 13h; 4d 12h to 16h and 5d 12h to 16h ... ... [4]

(14.) Two bar magnets brought into the room to twist the vertical force magnet in azimuth:
for 1879, February 10d 12h ... ... [1]

(15.) Alteration being made to increase the play of the vertical force shutter:
for 1874, May 14d (10h) ... ... [3]

(16.) Deflection experiments going on:
for 1873, September 11d 14h; 1879, February 11d 12h; and 1880, April 17d 12h ... ... [1]
for 1872, April 10d 15h; 1873, October 4d 11h; 1876, August 10d 12h and 13h; 1877, February 5d 13h and 1878, February 6d 12h ... [2]

(17.) Vibration experiments going on:
for 1872, February 29d 12h to 18h ... ... [4]

(18.) Heating experiments in progress: effect of temperature changes variable and uncertain; treated as an interruption;
for 1880, January 26d 7h to 9h ... ... [2]

(19.) Curve affected by leakage of air into the enclosure:
for 1877, April 12d 17h to 23h ... ... [2]

(20.) Preparation for and attempts made to pump the air out of the enclosure of the instrument:
for 1874, November 17d 12h; and 1877, February 7d 12h to 18h; 8d 12h to 18h; 9d 8h; 15d 17h and 18h; 16d 16h; 17d 11h to 19h; 18d 8h; and 22d 11h and 12h, and March 2d 13h ... ... [2]
for 1874, May 27d, 11h to (14h) and 15h; and 1880, January 22d 12h to (14h), 15h, (16h) and 17h ... ... [2 and 3]
for 1872, March 13d 12h to 16h; 14d 14h; 15d 15h to 19h and 20d 12h to 16h ... ... [4]

Rule of Interpolation, &c.

(21.) "Set" of instrument accidentally disturbed:
for 1872, February 28^d 16^h and 17^h and March 6^d 15^h ... ... [4]

VERTICAL FORCE MAGNETOGRAPH.

268. *List of days the curves of which were rejected.*

1872, May 24 and 25... } Datum line lost or too faint for tabulation.
„ June 23 and 24... }

1873, May 17 and 18... } Datum line lost or too faint for tabulation.
„ May 21 ... }

„ September 12 and 13 ...Deflection experiments going on.

1876, July 7 to 14 ... Instrument being re-adjusted and air pumped out of enclosure, &c., up to 10th, afterwards scale-reading changing rapidly.

1878, April 3 to 5 ... Curves lost, owing to bad quality of waxed paper or bad photography.

1879, February 15 and 16 ... Heating experiments going on in the magnetograph room: effect of temperature changes variable and uncertain.

1875, September 26^d 10^h to 28^d 9^h: Datum lines both lost: this is the single case, alluded to above, for which an artificial datum was drawn.

269. *Curve affected and corrections applied to tabulations.*

1876, June 30 ... Deflection experiments made upon vertical force magnetograph; dislocation of −·035 was allowed for from 10^h to 13^h.

1877, May 3 ... Deflection experiments made upon vertical force magnetograph; dislocation of +·003 was allowed for 10^h, 11^h and 13^h.

1879, February 8 ... Deflection experiments made upon vertical force magnetograph; dislocation of −·013 was allowed for from 10^h to 13^h.

1879, February 10... Deflection experiments made upon vertical force magnetograph: dislocation of +·010 was allowed for from 10^h to 14^h.

270. *Entries in abstracts obtained by interpolation or by substitution of eye-observations —not by direct tabulation.*

Rule of interpolation, &c.

(1.) Owing to stoppage of clock:
for 1877, July 11^d 18^h; and 1878, January 24^d 20^h ... ... [1]
for 1873, July 23^d 3^h to 6^h; and August 24^d 13^h; 1874, January 8^d 2^h; April 29^d 5^h and 6^h and December 22^d 13^h; and 1875, January 14^d 13^h and 21^h to 23^h ... ... [2]
for 1878, January 18^d 16^h ... ... [3]

(2.) Clock being cleaned or taken to pieces:
for 1874, April 29^d 8^h to 14^h ... ... [2]

(3.) Derangement of clock-work being rectified:
for 1877, February 27^d (10^h) ... ... [3]

(4.) String of driving weight deranged whilst winding the clock:
for 1874, January 9^d 10^h ... ... [2]

(5.) Owing to failure of light:
for 1873, August 24^d 13^h ... ... [1]
for 1877, November 4^d 0^h and 1^h ... ... [2]

(6.) Owing to faulty waxed paper:
for 1877, April 15^d 9^h ... ... [1]
for 1875, September 26^d (10^h) ... ... [3]

(7.) Curves lost or too faint to tabulate: photography at fault:
for 1874, July 29^d 10^h to 13^h and 15^h and 17^h ... ... [2]
for 1875, September 22^d (10^h) to 13^h and 23^d (10^h) to 12^h; and 1877, July 27^d (22^h) to 28^d 4^h and 28^d (22^h) to 29^d 4^h ... ... [2 and 3]

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* The numbers within square brackets indicate the rules by which the interpolations or substitutions were made.

Rule of interpolation, &c.

(8.) Paper being changed or curve passed over binding rods at $9^h\ 17^m$: tabulation at $9^h\ 15^m$ adopted:
for 1872, May $17^d\ 9^h$ and December $8^d\ 9^h$.

(9.) Alteration being made to increase the play of the vertical force shutter:
for 1874, May $14^d\ 10^h$ ... ... [1]

(10.) Deflection experiments going on:
for 1876, July $3^d\ 16^h$ ... ... [1]
for 1876, June $29^d\ 16^h$ to 18^h; and $30^d\ 14^h$ to 21^h: August $8^d\ 11^h$ and 12^h; 1877, May $3^d\ 12^h$, 14^h and 15^h; and November $10^d\ 12^h$ and 13^h;
and 1879, February $8^d\ 14^h$ to 17^h and $10^d\ 15^h$ to 17^h ... ... [2]

(11.) Curve rejected, owing to the occurrence immediately after of a large dislocation:
for 1874, August $25^d\ 10^h$ ... ... [2]

271. List of dislocations of the vertical force magnetograms and of the corrections applied, on account of them, to make the whole of every day's tabulations comparable amongst themselves:—

Month and Year.	Hours for which correction is applied.	Correction.	Month and Year.	Hours for which correction is applied.	Correction.	Month and Year.	Hours for which correction is applied.	Correction.
	d. h. d. h.			d. h. d. h.			d. h. d. h.	
1872 May ...	12 10 to 12 14	+·032	1874 January...	29 6 to 29 9	−·015	1875 Sept. ...	21 10 to 21 13	−·025
„ „ ...	31 1 to 31 9	−·011	„ February...	11 10 to 11 16	−·034	„ October ...	2 10 to 2 12	+·012
„ June ...	8 10 to 8 16	+·016	„ „ ...	24 10 to 24 19	−·017	„ „ ...	26 10 to 26 15	−·024
„ „ ...	19 7 to 19 9	−·023	„ „ ...	25 7 to 25 9	−·017	1875 January..	3 10 and 3 11	−·013
„ July ...	17 10 to 17 14	+·019	„ March ...	14 7 to 14 9	−·007	„ February .	22 10 to 22 12	−·007
„ August ...	18 10 to 18 16	+·011	„ „ ...	29 10 to 29 18	+·011	„ March ...	9 23 to 10 9	+·006
„ „ ...	19 6 to 19 9	−·017	„ April ...	19 10	+·005	„ April ...	14 10	−·004
„ „ ...	21 7 to 21 9	−·012	„ May ...	6 10	+·005	„ „ ...	21 10	−·004
„ „ ...	23 10	−·018	„ June ...	3 6 to 3 9	−·020	„ June ...	1 10 to 1 18	−·004
„ September.	7 3 to 7 9	−·014	„ „ ...	14 10	−·013	„ „ ...	6 10 and 6 11	+·012
„ October ...	12 10 to 12 20	−·009	„ August ...	26 10 to 26 13	+·010	„ „ ...	7 10 to 7 14	−·046
„ November.	3 10 to 3 14	+·011	„ „ ...	26 14 to 26 18	−·006	„ „ ...	7 15 to 7 18	−·051
„ „ ...	5 10 to 5 12	+·008	„ September.	8 10	−·014	„ „ ...	8 10	−·035
„ „ ...	15 10 to 15 14	+·014	„ „ ...	8 11 to 8 13	−·029	„ „ ...	9 10 to 9 12	−·015
„ „ ...	18 2 to 18 9	−·008	„ „ ...	14 10 to 14 15	+·019	„ „ ...	10 10 to 10 12	+·007
„ „ ...	19 10 to 19 16	−·010	„ „ ...	14 16	+·012	„ „ ...	19 10 to 19 16	−·005
„ December.	9 10 to 9 16	+·006	„ „ ...	17 10 to 17 18	+·005	„ „ ...	30 22	−·020
„ „ ...	17 7 to 17 9	−·004	„ „ ...	18 7 to 18 9	−·008	„ July ...	3 10 to 3 14	−·034
„ „ ...	26 7 to 26 9	−·009	„ Oct.-Nov..	31 22 to 1 9	−·004	„ „ ...	3 23 to 4 9	+·007
1873 January .	3 7 to 3 9	−·011	„ November.	17 10 to 17 16	+·002	„ August ...	7 10 to 7 15	+·017
„ „ ...	7 10 to 7 14	+·042	„ December.	17 7 to 17 9	+·013	„ „ ...	7 16 to 7 18	+·009
„ „ ...	7 15 and 7 16	+·029	„ „ ...	24 8 and 24 9	−·009	„ „ ...	19 10 and 19 11	+·021
„ „ ...	8 10 to 8 14	+·005	1875 February.	9 10 to 9 18	+·008	„ December.	19 10 to 19 19	−·011
„ „ ...	9 10	+·019	„ „ ...	15 10 to 15 17	+·021	1877 January .	16 7 and 16 8	+·006
„ „ ...	9 11 to 9 16	+·014	„ „ ...	19 4 to 19 9	+·018	„ „ ...	16 9	+·001
„ „ ...	12 10 to 12 18	+·012	„ „ ...	22 10 to 22 17	+·006	„ „ ...	26 22 to 27 9	+·007
„ February .	28 10 to 28 16	+·011	„ March ...	5 10 to 5 16	−·009	„ February .	10 10 to 10 12	+·008
„ March ...	1 10 to 1 16	+·004	„ „ ...	9 10 to 9 17	−·003	„ „ ...	10 13 to 10 16	+·004
„ „ ...	11 10 to 11 19	+·005	„ April ...	26 10 to 26 14	−·010	„ „ ...	13 23 to 14 9	−·007
„ „ ...	19 10 to 19 20	+·004	„ „ ...	27 10 to 27 17	+·028	„ May ...	3 11 and 3 13	+·009
„ April ...	6 6 to 6 9	−·005	„ May ...	24 10 to 24 18	+·019	„ June ...	22 10 to 22 14	+·010
„ May ...	10 10 to 10 12	+·011	„ „ ...	30 23 to 31 9	−·013	„ August ...	26 10 to 26 13	+·012
„ „ ...	13 1 to 13 9	−·011	„ „ ...	31 10 to 31 18	+·013	„ September.	15 10 to 15 13	+·005
„ „ ...	23 10 to 23 12	+·039	„ June ...	10 7 to 10 9	−·007	„ „ ...	27 10 to 27 16	+·007
„ June ...	12 7 to 12 9	−·014	„ July ...	7 10 to 7 14	+·009	„ October ...	7 10 to 7 21	+·006
„ „ ...	25 3 to 25 9	−·016	„ „ ...	14 23 to 15 9	+·012	„ November.	6 10 to 6 17	+·008
„ September	28 10 to 28 12	+·012	„ „ ...	23 10 to 23 16	−·015	„ „ ...	10 8 and 10 9	+·016
„ October ...	1 10 and 1 11	+·011	„ „ ...	24 8 and 24 9	−·008	1878 February.	13 10 to 13 16	+·007
„ „ ...	1 12 to 1 16	+·020	„ August ...	8 10 to 8 12	−·008	„ „ ...	26 10 to 26 17	−·014
„ „ ...	1 17 and 1 18	+·005	„ „ ...	18 10 to 18 20	−·005	„ March ...	28 7 to 28 9	+·004
„ November.	1 10 to 1 20	−·007	„ „ ...	22 7 to 22 9	−·009	„ August ...	13 10 to 13 16	+·022
„ „ ...	16 10 to 16 16	+·004	„ „ ...	26 10 to 26 16	−·006	„ October ...	22 10 to 22 17	+·008
„ „ ...	29 10 to 29 12	+·006	„ „ ...	28 10 to 28 16	−·014	„ November.	21 10 to 21 17	−·006
„ „ ...	30 10 to 30 18	+·012	„ „ ...	29 23 to 30 9	+·012	1879 January .	10 6 to 10 9	+·017
„ December.	3 1 to 3 9	+·022	„ September.	4 7 to 4 9	+·015	„ February .	7 10 to 7 12	+·002
„ „ ...	11 10 to 11 18	+·008	„ „ ...	12 10 to 12 13	+·016	„ „ ...	8 10 and 8 11	+·012
1874 January..	5 23 to 6 9	−·005	„ „ ...	20 10 to 20 14	−·014			

Dislocations that occurred between $9^h\ 17^m$ and $10^h\ 17^m$ are not entered in this list because they do not affect the comparability of the complete day's tabulations.

APPENDIX V.

Influence of height above or below the ground level upon the Diurnal Variations of Declination and Horizontal Force.

272. The heights of the magnetometers and magnetographs are respectively 6 feet above and 7½ feet below the general ground level; and the comparison has been made for the year 1872, when the hourly observations of the magnetometers were still maintained and the magnetographs were, speaking generally, in continuous action. All available days were included in each month's abstracts, regardless of the precaution that would have thrown out days in one abstract, of which there were no counterparts in the corresponding abstract. No regard has been paid either to the difference of time at which the observations are taken and for which the tabulations are made, these differences being 6 minutes in the case of the declination and 5 minutes in the case of the horizontal force; but a cursory inspection of Figs. 677 to 688 and 803 to 814 together with Figs. 664, 801 and 802 (to be presently described) will show that, with two exceptions, no considerable part of the difference variations that we find is, in any case, due to these small differences in the moment of observation; the excepted cases are the month of February and 5 hours of the month of October, when large disturbances caused considerable movements of the magnet to take place in short times.

273. The magnetograph variations used for this purpose are those shown in Tables 126 and 137, the latter after correction for the progressive changes shown at the feet of the several columns; those of the megnetometers are shown in Tables 161 and 163 below; and the excess variations, or the excesses of the hourly magnetometer inequalities over the respective hourly magnetograph inequalities are shown in Tables 162 and 164.

TABLE 161.—*Grubb's Declination Magnetometer*
showing the mean diurnal variation of Declination for each month of the year 1872 *and for the whole year.*

1872.	Month.												Year.
Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h. m.													
10 12	+·00146	+·00148	+·00025	+·00030	—·00099	—·00053	—·00056	—·00063	—·00046	·00000	+·00030	+·00004	+·00005
11 12	+·00092	+·00058	—·00108	—·00131	—·00245	—·00185	—·00209	—·00214	—·00263	—·00127	—·00059	—·00077	—·00122
12 12	+·00039	+·00002	—·00180	—·00233	—·00337	—·00240	—·00263	—·00298	—·00381	—·00174	—·00043	—·00071	—·00182
13 12	+·00010	—·00001	—·00174	—·00252	—·00290	—·00226	—·00260	—·00294	—·00350	—·00123	+·00019	+·00020	—·00160
14 12	—·00030	—·00010	—·00082	—·00190	—·00197	—·00190	—·00190	—·00202	—·00220	—·00046	+·00050	+·00076	—·00103
15 12	—·00036	—·00047	+·00004	—·00109	—·00082	—·00129	—·00102	—·00108	—·00081	+·00022	+·00051	+·00081	—·00045
16 12	—·00014	—·00070	+·00018	—·00041	+·00007	—·00053	—·00041	—·00010	—·00002	+·00017	+·00014	+·00053	—·00010
17 12	+·00014	—·00086	—·00015	—·00033	+·00010	+·00010	+·00022	+·00027	+·00003	—·00051	—·00035	—·00029	—·00016
18 12	—·00038	—·00095	—·00073	—·00059	—·00009	+·00024	+·00014	+·00017	—·00015	—·00039	—·00031	—·00021	—·00027
19 12	—·00001	—·00045	—·00039	—·00066	—·00066	—·00035	—·00040	—·00032	+·00001	—·00007	—·00001	+·00002	—·00027
20 12	—·00001	—·00034	—·00027	—·00053	—·00059	—·00055	—·00062	—·00046	—·00001	+·00001	—·00004	+·00004	—·00028
21 12	—·00003	—·00025	—·00026	—·00027	—·00027	—·00040	—·00041	—·00041	+·00001	—·00011	—·00006	—·00006	—·00021
22 12	+·00013	—·00024	—·00004	+·00002	—·00003	—·00015	—·00037	—·00036	+·00013	—·00007	+·00017	+·00007	—·00006
23 12	+·00016	—·00014	+·00019	+·00018	+·00014	+·00001	—·00022	—·00030	+·00015	+·00018	+·00032	+·00020	+·00007
0 12	+·00024	+·00074	+·00025	+·00056	+·00029	+·00018	+·00007	+·00001	+·00044	+·00021	+·00039	+·00014	+·00029
1 12	+·00016	+·00065	+·00025	+·00059	+·00041	+·00036	+·00039	+·00019	+·00045	+·00019	+·00026	+·00028	+·00035
2 12	+·00007	+·00059	+·00016	+·00057	+·00056	+·00047	+·00056	+·00042	+·00056	+·00022	+·00024	+·00013	+·00036
3 12	—·00017	+·00030	—·00001	+·00047	+·00056	+·00053	+·00062	+·00054	+·00049	+·00008	—·00005	—·00001	+·00027
4 12	—·00038	—·00020	—·00018	+·00027	+·00066	+·00059	+·00072	+·00058	+·00040	—·00021	—·00040	—·00013	+·00014
5 12	—·00062	—·00062	—·00020	+·00041	+·00125	+·00104	+·00119	+·00105	+·00057	—·00016	—·00073	—·00035	+·00024
6 12	—·00071	—·00061	+·00038	+·00146	+·00280	+·00225	+·00267	+·00255	+·00198	+·00050	—·00076	—·00042	+·00101
7 12	—·00106	—·00047	+·00175	+·00276	+·00331	+·00297	+·00328	+·00362	+·00336	+·00157	—·00048	—·00063	+·00166
8 12	—·00023	+·00060	+·00247	+·00261	+·00282	+·00243	+·00256	+·00313	+·00326	+·00176	+·00046	—·00010	+·00181
9 12	+·00095	+·00147	+·00167	+·00170	+·00116	+·00108	+·00090	+·00128	+·00169	+·00119	+·00080	+·00039	+·00119

TABLE 162.—*Excesses of hourly inequalities of declination as shown by Grubb's Declination Magnetometer over the same as shown by the Declination Magnetograph.*

1872.	MONTH.												January and March to December.
Bombay Civil Time.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
h.													
10 ...	+·00003	+·00008	−·00006	+·00005	+·00004	+·00006	+·00012	−·00004	+·00019	+·00003	+·00008	+·00007	+·00005
11 ...	+·00002	+·00002	−·00015	+·00006	+·00001	+·00014	+·00002	+·00004	+·00004	−·00003	−·00003	+·00007	+·00002
12 ...	−·00014	−·00007	−·00012	+·00003	−·00014	+·00015	+·00007	+·00004	−·00011	−·00009	−·00021	−·00012	−·00006
13 ...	−·00024	+·00002	−·00019	−·00013	−·00013	+·00010	−·00002	+·00001	−·00017	−·00020	−·00018	−·00002	−·00011
14 ...	−·00011	−·00001	−·00026	−·00019	−·00020	+·00003	−·00010	+·00006	−·00024	−·00018	−·00012	−·00005	−·00012
15 ...	+·00001	+·00009	−·00015	−·00022	−·00023	−·00008	−·00015	−·00009	−·00016	−·00003	+·00001	−·00009	−·00011
16 ...	−·00008	−·00002	−·00007	−·00019	−·00015	−·00003	−·00010	+·00002	−·00005	+·00005	−·00005	−·00006	−·00006
17 ...	+·00002	−·00002	+·00004	−·00011	−·00012	+·00004	·00000	−·00004	+·00003	+·00005	−·00007	−·00007	−·00002
18 ...	−·00004	−·00005	+·00002	−·00003	−·00003	+·00008	−·00005	+·00005	+·00004	−·00005	−·00019	−·00018	−·00003
19 ...	−·00010	−·00008	−·00005	+·00002	−·00007	+·00009	+·00004	+·00002	+·00023	−·00001	−·00007	−·00010	·00000
20 ...	−·00007	+·00003	+·00004	+·00003	−·00015	−·00002	−·00006	+·00004	−·00004	−·00002	−·00004	−·00005	−·00003
21 ...	−·00009	·00000	+·00002	+·00004	−·00005	+·00003	−·00004	+·00006	+·00001	+·00005	−·00009	−·00009	−·00002
22 ...	−·00006	−·00080	−·00001	−·00001	−·00003	+·00001	−·00006	+·00004	−·00003	−·00007	+·00001	−·00002	−·00002
23 ...	−·00006	−·00051	−·00003	−·00001	+·00008	−·00008	−·00013	−·00002	−·00010	+·00002	+·00004	−·00002	−·00003
0 ...	−·00001	+·00015	+·00003	+·00006	−·00002	−·00004	+·00001	+·00007	·00000	−·00001	+·00008	−·00008	+·00001
1 ...	−·00003	+·00015	·00000	+·00009	+·00004	−·00008	+·00005	+·00003	−·00008	+·00003	+·00001	+·00006	+·00001
2 ...	+·00004	+·00028	+·00004	+·00004	+·00003	−·00006	+·00006	+·00011	+·00009	+·00003	+·00005	−·00003	+·00004
3 ...	+·00008	+·00030	+·00008	+·00007	+·00009	−·00006	·00000	+·00004	+·00002	+·00008	+·00011	−·00001	+·00005
4 ...	+·00012	+·00024	+·00004	+·00005	+·00007	−·00003	+·00004	+·00008	·00000	+·00001	+·00013	+·00009	+·00005
5 ...	+·00019	+·00006	+·00008	−·00003	+·00004	−·00002	−·00002	−·00004	+·00001	+·00003	+·00005	+·00012	+·00004
6 ...	+·00025	+·00017	+·00001	−·00019	·00000	−·00033	+·00009	−·00019	−·00010	+·00013	+·00017	+·00017	·00000
7 ...	+·00034	+·00003	+·00026	−·00001	+·00005	+·00002	+·00020	−·00005	·00000	+·00005	+·00017	+·00009	+·00010
8 ...	+·00024	+·00010	+·00036	·00000	+·00018	−·00003	+·00010	+·00011	+·00024	+·00011	+·00015	+·00009	+·00014
9 ...	−·00011	−·00002	+·00008	+·00021	+·00035	+·00027	+·00012	+·00004	+·00029	+·00004	+·00005	−·00014	+·00011

Table 163.—Grubb's Horizontal Force Magnetometer.

Showing the mean diurnal variation of Horizontal Force for each month of the year 1872 and for the whole year.

1872. Bombay Civil Time.		MONTH.												Year.
h.	m.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
10	14 ...	+ ·00346	+ ·00445	+ ·00483	+ ·00565	+ ·00544	+ ·00412	+ ·00430	+ ·00423	+ ·00423	+ ·00428	+ ·00423	+ ·00368	+ ·00442
11	14 ...	+ ·00439	+ ·00500	+ ·00582	+ ·00626	+ ·00576	+ ·00461	+ ·00456	+ ·00478	+ ·00511	+ ·00483	+ ·00516	+ ·00423	+ ·00504
12	14 ...	+ ·00439	+ ·00516	+ ·00533	+ ·00549	+ ·00516	+ ·00445	+ ·00439	+ ·00467	+ ·00500	+ ·00417	+ ·00467	+ ·00401	+ ·00474
13	14 ...	+ ·00362	+ ·00428	+ ·00445	+ ·00461	+ ·00395	+ ·00368	+ ·00335	+ ·00384	+ ·00439	+ ·00225	+ ·00357	+ ·00307	+ ·00375
14	14 ...	+ ·00264	+ ·00280	+ ·00296	+ ·00280	+ ·00247	+ ·00231	+ ·00220	+ ·00264	+ ·00302	+ ·00055	+ ·00253	+ ·00242	+ ·00244
15	14 ...	+ ·00170	+ ·00181	+ ·00137	+ ·00121	+ ·00093	+ ·00110	+ ·00115	+ ·00126	+ ·00159	− ·00044	+ ·00148	+ ·00165	+ ·00123
16	14 ...	+ ·00088	+ ·00104	+ ·00044	− ·00005	− ·00016	− ·00016	− ·00011	+ ·00016	+ ·00066	− ·00071	+ ·00016	+ ·00066	+ ·00023
17	14 ...	+ ·00033	+ ·00038	− ·00082	− ·00066	− ·00082	− ·00104	− ·00099	− ·00033	− ·00016	− ·00159	− ·00049	+ ·00011	− ·00052
18	14 ...	− ·00027	− ·00022	− ·00176	− ·00110	− ·00154	− ·00137	− ·00159	− ·00099	− ·00099	− ·00143	− ·00088	− ·00033	− ·00104
19	14 ...	− ·00066	− ·00077	− ·00220	− ·00159	− ·00187	− ·00132	− ·00198	− ·00154	− ·00176	− ·00165	− ·00159	− ·00077	− ·00147
20	14 ...	− ·00165	− ·00104	− ·00253	− ·00220	− ·00236	− ·00159	− ·00209	− ·00170	− ·00181	− ·00203	− ·00242	− ·00148	− ·00191
21	14 ...	− ·00236	− ·00137	− ·00253	− ·00225	− ·00274	− ·00176	− ·00209	− ·00187	− ·00198	− ·00220	− ·00269	− ·00214	− ·00216
22	14 ...	− ·00264	− ·00159	− ·00274	− ·00242	− ·00285	− ·00198	− ·00181	− ·00170	− ·00236	− ·00176	− ·00253	− ·00247	− ·00224
23	14 ...	− ·00242	− ·00154	− ·00258	− ·00274	− ·00280	− ·00192	− ·00176	− ·00148	− ·00242	− ·00165	− ·00231	− ·00253	− ·00218
0	14 ...	− ·00225	− ·00450	− ·00225	− ·00274	− ·00231	− ·00181	− ·00198	− ·00203	− ·00236	− ·00143	− ·00203	− ·00220	− ·00232
1	14 ...	− ·00192	− ·00428	− ·00269	− ·00269	− ·00231	− ·00148	− ·00225	− ·00209	− ·00214	− ·00115	− ·00181	− ·00220	− ·00220
2	14 ...	− ·00198	− ·00412	− ·00214	− ·00247	− ·00225	− ·00170	− ·00214	− ·00214	− ·00187	− ·00093	− ·00181	− ·00154	− ·00269
3	14 ...	− ·00192	− ·00318	− ·00176	− ·00236	− ·00203	− ·00192	− ·00236	− ·00209	− ·00170	− ·00066	− ·00187	− ·00165	− ·00195
4	14 ...	− ·00165	− ·00242	− ·00176	− ·00236	− ·00203	− ·00192	− ·00209	− ·00209	− ·00165	− ·00011	− ·00176	− ·00148	− ·00177
5	14 ...	− ·00176	− ·00242	− ·00143	− ·00214	− ·00187	− ·00187	− ·00176	− ·00198	− ·00176	− ·00060	− ·00159	− ·00137	− ·00171
6	14 ...	− ·00132	− ·00170	− ·00154	− ·00165	− ·00148	− ·00137	− ·00115	− ·00159	− ·00181	− ·00088	− ·00132	− ·00104	− ·00140
7	14 ...	− ·00049	− ·00049	− ·00093	− ·00110	− ·00022	− ·00022	+ ·00011	− ·00066	− ·00165	− ·00049	− ·00038	− ·00049	− ·00058
8	14 ...	+ ·00055	+ ·00137	+ ·00077	+ ·00093	+ ·00176	+ ·00115	+ ·00198	+ ·00082	− ·00016	+ ·00082	+ ·00082	+ ·00038	+ ·00093
9	14 ...	+ ·00192	+ ·00313	+ ·00291	+ ·00357	+ ·00401	+ ·00258	+ ·00384	+ ·00242	+ ·00225	+ ·00258	+ ·00280	+ ·00209	+ ·00284

TABLE 165.—*Showing the diurnal variation of the readings of the Thermometer of Grubb's Horizontal Force Magnetometer for each month of the year* 1872 *and for the groups of months March to October and November to January.*

1872.	MONTH.												Mar. to Oct.	Nov. to Jan.
Bombay Civil time.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.		
h.														
10	−1·23	−1·14	− ·37	− ·25	− ·06	−·13	+·08	+·03	+ ·01	− ·33	− ·93	− ·63	− ·13	− ·93
11	− ·53	− ·36	+ ·11	+ ·17	+ ·28	+·16	+·34	+·32	+ ·34	+ ·09	− ·27	− ·15	+ ·23	− ·32
12	+ ·11	+ ·36	+ ·53	+ ·55	+ ·52	+·34	+·51	+·68	+ ·63	+ ·48	+ ·27	+ ·27	+ ·53	+ ·22
13	+ ·75	+1·07	+ ·88	+ ·86	+ ·82	+·58	+·64	+·85	+ ·90	+ ·86	+ ·97	+ ·65	+ ·80	+ ·79
14	+1·33	+1·58	+1·16	+1·12	+1·07	+·73	+·66	+·97	+1·02	+1·11	+1·64	+1·10	+ ·98	+1·36
15	+1·72	+1·96	+1·26	+1·16	+1·23	+·83	+·69	+·97	+1·12	+1·33	+2·09	+1·45	+1·07	+1·75
16	+1·91	+2·02	+1·19	+1·11	+1·20	+·82	+·65	+·83	+1·02	+1·36	+2·17	+1·56	+1·02	+1·88
17	+1·83	+1·85	+ ·93	+ ·95	+1·07	+·64	+·59	+·69	+ ·69	+1·19	+1·94	+1·47	+ ·84	+1·75
18	+1·46	+1·41	+ ·53	+ ·61	+ ·73	+·45	+·33	+·38	+ ·37	+ ·88	+1·49	+1·17	+ ·53	+1·37
19	+1·23	+1·12	+ ·33	+ ·34	+ ·42	+·20	+·14	+·11	+ ·14	+ ·72	+1·24	+1·01	+ ·30	+1·16
20	+ ·96	+ ·90	+ ·19	+ ·20	+ ·27	+·07	−·01	−·02	+ ·06	+ ·61	+ ·97	+ ·81	+ ·17	+ ·91
21	+ ·79	+ ·70	+ ·14	+ ·12	+ ·18	·00	−·09	−·09	− ·03	+ ·47	+ ·59	+ ·54	+ ·09	+ ·64
22	+ ·58	+ ·52	+ ·06	+ ·05	+ ·07	−·03	−·17	−·18	− ·10	+ ·26	+ ·21	+ ·21	·00	+ ·33
23	+ ·36	+ ·27	+ ·10	− ·03	− ·07	−·11	−·22	−·25	− ·20	+ ·04	− ·13	− ·20	− ·09	+ ·01
0	+ ·01	− ·37	− ·20	− ·24	− ·29	−·04	−·26	−·29	− ·41	− ·18	− ·24	− ·21	− ·24	− ·15
1	− ·23	− ·54	− ·29	− ·31	− ·47	−·22	−·28	−·38	− ·49	− ·40	− ·48	− ·41	− ·35	− ·37
2	− ·46	− ·67	− ·36	− ·41	− ·58	−·30	−·35	−·45	− ·57	− ·60	− ·75	− ·53	− ·45	− ·58
3	− ·69	− ·89	− ·46	− ·53	− ·71	−·40	−·40	−·51	− ·64	− ·83	− ·97	− ·65	− ·56	− ·77
4	−1·00	−1·02	− ·59	− ·70	− ·84	−·54	−·42	−·62	− ·69	− ·97	−1·21	− ·85	− ·67	−1·02
5	−1·31	−1·27	− ·73	− ·82	− ·98	−·60	−·50	−·69	− ·75	−1·22	−1·47	−1·01	− ·79	−1·26
6	−1·61	−1·61	− ·97	− ·98	−1·15	−·70	−·57	−·68	− ·75	−1·38	−1·77	−1·33	− ·90	−1·57
7	−2·01	−1·98	−1·25	−1·11	−1·14	−·71	−·61	−·68	− ·79	−1·44	−1·98	−1·53	− ·97	−1·84
8	−2·11	−2·11	−1·30	−1·08	− ·93	−·61	−·46	−·56	− ·63	−1·24	−1·92	−1·53	− ·85	−1·85
9	−1·84	−1·78	− ·97	− ·72	− ·53	−·44	−·24	−·37	− ·30	− ·78	−1·49	−1·12	− ·54	−1·48

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